DOCUMENT RESUME

ED 146 646 HE 009 412

TITLE Biological Sciences in Advanced Further Education. Coombe Lodge Report, Study Conference 75/2.
INSTITUTION Further Education Staff Coll., Blagdon (England).
PUB DATE 75
NOTE 94p.; Papers presented at a conference
AVAILABLE FROM Report Editor, Coombe Lodge, Blagdon, Bristol BS18 6RG, England (One pound ten pence)

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Biological Sciences; *Biology Instruction; *Certification; Curriculum Development; Degree Requirements; *Degrees (Titles); Departments; Effective Teaching; Employment Qualifications; Foreign Countries; *Health Occupations Education; Health Personnel; Higher Education; Manpower Needs; *Paramedical Occupations; Post Secondary Education; Science Laboratories; Scientific Research
IDENTIFIERS *Great Britain

ABSTRACT

Biology is an important growth area in postsecondary education in Great Britain, although confined to a small number of institutions. Papers presented on this topic include: trends and developments (E. Norris); biological manpower (B. Gregson-Allcott); laboratory design (A.J. Branton, F. Drake); the place of research (K. Wilson); Degree and Institute of Biology qualifications (F.C. Webber); medical technician qualifications (S.F. Everiss); higher national diplomas and certificates (I.G. North); introduction to project A, to review the current range of courses and qualifications in the advanced biomedical sector (T. Green); introduction to project B, to consider the factors affecting biology teaching and make the best use of limited resources (R.W. Thomas); and introduction to project C, to consider the ways biology departments could respond if the education service were required to assume wider responsibilities for paramedical training (E. Norris). (MSE)

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ED146846

Coombe Lodge Report

Vol 8 No 3

Study Conference 75/2

Biological Sciences in Advanced Further Education

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Printed offset lithography on Crown quarto by Messrs. Hiscox & Lambert Ltd. Bristol.

BIOLOGICAL SCIENCES IN ADVANCED FURTHER EDUCATION

Vol. 8. No. 3. 1975.

Study Conference 75/2

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FOREWORD

In January 1975 the first conference specially restricted to biology in further education was held at Coombe Lodge. It gave an opportunity for participants to explore current trends and developments in the organisation and teaching of the life sciences in advanced further education.

While staff in many other areas of further education have to struggle with problems arising from declining student numbers, biologists have more satisfying issues to deal with, for statistics show biology to be an important growth area in FE. This growth does, however, seem to be confined to a limited number of institutions, most of which were represented at the conference.

Among the many topics discussed during the week were the present multiplicity of courses, examinations and qualifications; current considerations as to the final disposal of paramedical courses between the education service and the health service; sandwich placement and retraining for physical science staff undertaking an increasing work load in biological science departments and sections.

Papers were given by visiting speakers on a range of topics and a tour was made of the new laboratories being built at Bristol Polytechnic. In addition to the papers included in this report, Dr. D.W. Hill of the Research Department of Anaesthetics at the Royal College of Surgeons spoke on the work of physicists in relation to the life sciences, describing, for example, the machinery they develop for use in biology.

E Norris,
MI, Department
of Education
and Science.

TRENDS AND DEVELOPMENTS

"Any consideration of the further and higher education scene is hampered by three problems: the information one has is not the information one wants; the information one needs is not the information which one can obtain; and more seriously, the information one believes one wants is not the information which one actually needs.

purpose of public education

Throughout Western society Governments are considering the money which is allocated for further and higher education and how it should be spent. They are concerned with the purpose of education, standards and discipline, in both the behavioural and learning sense. The underlying purpose of public education for the past 100 years - since it began - has been based upon three planning parameters:

(a) to supply manpower for a rapidly evolving technological society which demands an increase in the number of people with skills and an increase in the quality, diversity and sophistication of the knowledge they are expected to be able to handle;

(b) that there is a close relationship between the quality and sophistication of the manpower produced and the size and rate of technological development and hence the rate of growth;

(c) that this technological evolution is a process which should be maintained in order to generate growth and that it is highly desirable that the process should be accelerated. (The assumption that the process cannot be stopped is also implied.)

The root cause of our current difficulties is that these three planning parameters have become seriously unstuck. Speaking mainly in terms of science and technology, it seems that technological evolution is not an ongoing process or one which cannot be halted. At present it is in collision with problems of resource depletion. Moreover, there never was, and probably never will be, a clear relationship between the number and type of manpower and the number, type and rate of technological evolution which is produced.

current trends

Marcus Tullius Cicero, if given the chance to study the statistics for further and higher education, would undoubtedly have cried "May the gods avert

the omen"! 1973 was the first year in which there was a fall in numbers. In the full time sector there was a shortfall of some 6,000 places, mostly in science and technology. It now seems fairly certain that FE and HE have stopped growing - and they may not begin to grow again in the way to which we have become accustomed until the end of the century. The recent decline is by no means a temporary aberration. It is due to a collection of complicated factors - one of these being the fact that people can no longer afford to be students - grants now compare very unfavourably with juvenile salaries. Even the long term financial benefits of post-school education, which in the past convinced many people that it was worthwhile, are no longer great enough to encourage people to enter HE. The starting salaries of graduates in relation to others entering employment have declined over the past ten years. The average life return for a higher education award has fallen from about 20-25% to less than 5%. In 1938 a professional earned between three and five times as much as a manual worker. Now the professional earns no more than 1.8 times the salary of a manual worker. The question of what rewards should be given to those who operate at a sophisticated level in our advanced technologies is a serious one, for without such people we cannot survive. There is an even more vital question - what more harmonious technological survival should they be taught to promote in order to achieve these rewards? We must not forget that the application of organised knowledge, especially in science and technology, by the products of FE and HE over the past century has increased the power of the manual worker who previously had to rely on the strength of his muscles alone by 1,000% - 3,000%, and has lifted him off the breadline, given him health, food and housing, and doubled his life span.

The innovation which ought now to be coming out of science and technology has been demotivated and blunted in a number of ways. A major factor is the declining status of the professional, which is by no means confined to the UK. Essentially, it is a reduction in the value that society places upon merit. Yet intelligence and high quality performance will be the basis of whatever success our society has in dealing with the seemingly intractable problems of our time. Society has to live by its wits in a period when the resources of the lands and oceans are no longer capable of supporting the load which is put upon them.

Statistics show that there is a declining proportion of two 'A' level holders going into HE. In 1969 the figure was 69%. Last year it had fallen to 63%. This has occurred at a time when the capacity of the HE system has been increased by 35-40% since 1960. In the current academic year, there are about 6,000 unfilled places, comprising approximately 2,000 engineering places (a sixth of the capacity), 3,000 science places (a third of the capacity) and 1,500 arts and languages places (an eighth of the capacity and the first time that surplus places have appeared in these fields).

These trends must be put into perspective:

(1) The expected increase in the demand for manpower was based upon predictions of the mid 1950s-1960s and was grossly over-estimated, resulting in a considerable over-capacity in HE and FE. There was probably sufficient capacity in the system by 1958-60 to meet all known needs in the training of scientists and technologists, even at that time when demand was increasing. Yet we built several new universities and other institutions on the basis of these predictions.

(2) There has been a pronounced swing away from full time to various forms of part time study, undertaken while in employment, including the Open University. (We should bear in mind that the Open University would have to lose 90% of its students before it approached the cost of the conventional HE system.) Therefore the decline in full time recruitment does not necessarily mean that young people are rejecting higher and further education, merely that they are regarding part time, often vocational, study as a more realistic alternative to full time study. Moreoever, while full time education was regarded as the best way of producing manpower quickly at a time when there was a shortage of highly qualified personnel, if there is less of a shortage it is possible to consider alternative methods of study, spreading it over a longer period of time and building up more flexibility. It would be fair to say that it is only in fields such as medicine, dentistry and pharmacy, where the full time course is compulsory or the course is highly vocational and a job at the end is virtually guaranteed that applications exceed intake.

The 1972 White Paper gave official recognition to this trend. Its title, "Education: A Framework for Expansion" was chosen with care. It was not a 'plan' or a 'programme' and therefore did not infer that HE would expand. It merely indicated that the way in which an expansion should be handled, if it did occur. The White Paper contained three important statements:

(1) that provision for vocational training was now more than adequate;

(2) that although we could expect more young people to get HE entry qualifications it was difficult to predict whether they would go into HE, what they would do when they did, and what they would do on leaving HE;

(3) that the number of young people is declining.

The administrative adjustments following the decline in the number of young people is still taking place. It was originally proposed that the higher education population should be raised from 400,000 to about 850,000. The most recently published adjustment has brought the target down to 700,000 and a figure of 500,000 is now being discussed.

The most significant trend which underlies these changes is the alteration in the birth rate which has taken place in the past five to seven years, because, once people are born, it becomes much easier to make predictions. At present

the primary school population is about 5.5 million. In July 1974 there were 780,000 young people leaving school - about 25% at 18, 30% at 17 and 50% at 16 (figures include those under 18 leaving full time FE). Projecting this to 1982, there will be 4.3 million primary school children (a drop of over one million) and 600,000 school leavers. By 1985 the number of school leavers will again have fallen to 500,000-550,000.

The consequence of this drop in numbers is difficult to predict. If we assume that technology keeps growing, that manpower patterns continue to demand skilled trained personnel in the same proportion of the total population (or even an increased proportion), the demands upon young people for their work (bearing in mind that about 40% of the population will be over 50) will be so great that students will have to be paid a large salary in order to persuade them to take full time courses. These pressures will affect the number of people in full time education and the distribution of students between full time and part time modes of study in ways we have not seen for the past 20 years at least.

Another aspect of the trend is a total swing away from science and technology and the swing, within the science and technology fields, between different areas of study. Many reasons for these movements have been suggested, but it should be emphasised that whatever technology is being practised the number of higher level scientists we have been producing up to the present time has been in considerable excess of the number who can be absorbed in employment of the type traditionally followed by this level of scientist. Therefore science graduates, like other graduates in the past, have had to learn that they must enter jobs unrelated to their field of academic study.

The concern for science education centres on criticisms of its past patterns of producing highly trained specialists who do not accept administrative and managerial jobs in the same way as other graduates. This may be true, but there is in fact a fair amount of evidence to show that the inability to adapt is more related to individuals than to any particular content of their training.

Part of the response to the situation is the current debate about the introduction of more flexible training - at the extreme, modular or even micro-modular courses - combining natural sciences, social sciences, technology and so on. I am not sure whether these are treading the thin line between genuine innovation and gimmickry, but I do know that one or two such courses have been devised to provide work for staff rather than meet a specific educational need, and this is something which must be examined. Modular or grouped course structures are obviously an advantage in the economic sense particularly in the life sciences where there are a greater number of different variations in the curriculum, but academically there must remain some doubts.

There are gulfs of knowledge between various subjects and it may be difficult for students to relate the various parts to each other. Inter-disciplinary relationships must have a conceptual or operational basis, and this does not always seem to exist.

A related issue is the amount of a subject a student needs to study before he really knows enough about it to be able to deal efficiently or effectively with it.

There is no doubt that the decline both in quality and quantity of science in schools is one of the factors responsible for the swing away from science and technology in FE. The past hopes of a rigorous overhaul have largely failed. Nuffield spent a lot of money improving what was already a comparatively well-taught area - sixth form science for the specialist - but the problem in school science is mainly at lower levels, for pupils of about 13 years of age. Nuffield later attempted to improve middle school science, but the exercise was rather half-hearted.

The situation is not helped by the 27% drop in the number of science graduates entering school teaching over the last five years. This may now correct itself, but quite a few sacred cows will have to be slaughtered before school science develops into something which the pupils like and enjoy.

Another current problem, and probably the one which has most effect, is the convulsive reorganisation of further and higher education. Circular 7/73 stipulated that colleges of education must combine with the rest of the system; that recruitment of teachers for the Certificate of Education had to be reduced by 25%-40% and that the colleges of education, in conjunction with their technical college colleagues had to diversify and find other work to do. It is difficult to know, as yet, what solutions are available. One possibility is the Dip.HE, but we do not know whether this will succeed. Once an institution passes from a vocational market into a more general one, so many factors affect whether people will decide to take its courses. We hopefully believe that experiments will prove that the trained product is better than the untrained one. There are also other reasons for taking a course of higher education - people think it will give status, be a good thing in itself, enable them to escape from the rigours of the economic world for a few years, and even help them to find a suitable marriage partner!

One of the problems for HE is that public opinion has changed. Now some people are beginning to feel that there is too much of it available for the school leaver, that more opportunity should be given to the mature student and the person who chooses to work at the same time as studying. If one may paraphrase Huxley, perhaps HE at present represents the slaying of a beautiful hypothesis by ugly fact. HE also suffers from being misinterpreted by the public. People tend to think of it as a commodity, that can be purchased in dollops, not understanding that it is impossible to teach anyone anything which they do not want to learn. Taking this a step further, real education, which may be vocational as well as academic, is limited to those who insist upon learning. The rest is merely a rather costly form of sheep-herding!

life sciences in FE and HE

The life sciences in colleges of technology and polytechnics have so far been relatively protected from the trends outlined above, but we must not delude

ourselves - we are by no means immune. There are several sections into which courses may be classified:

(a) degree level applied biology,

(b) technological biology (i.e. applied biology in the medical technology field),

(c) academic biology, mostly at GCE 'O' and 'A' level,

(d) ancillary biology (courses for hairdressing, catering, agricultural, beauty therapy students, etc.).

The reasons why the life sciences have been protected are:

(a) In terms of technical innovation it is a relatively new phenomenon having taken place since the mid 1950s.

(b) The subject continues to be popular. Moreover, the technologies associated with food, health and the environment have become increasingly important in recent years and have expanded their manpower.

(c) DES policy has been to limit the number of people studying the life sciences and to ensure that they do so in a limited number of centres. The statistics are quite revealing. Across the applied biology/medical technology spectrum there were this year between 2,200 and 2,500 first year entry HNC/HND students concentrated in 50 colleges. The sum total of the HND/HNC first year entry to chemistry and physics courses was 1,700 and they are spread among 102 colleges. Therefore most life science departments in colleges are large, averaging 63% of all the higher level science in technical colleges and polytechnics and in some cases comprising 90% of the colleges' advanced science work.

strengths and weaknesses of life sciences

This brings me to some of the strengths and weaknesses of life sciences in FE and HE. It is indirectly responsible for a whole complex of political, resource and emotional problems. Firstly there is simply more of it. Suddenly what used to be a small part of college work has expanded, giving rise to all sorts of difficulties, for until now the power structure of the technology side of British technical education has been dominated by the physical sciences and engineering.

Secondly, the life sciences are versatile. There is a tendency for courses to be multi-disciplinary and inter-disciplinary, involving more branches of science and mathematics than other technological areas of study. The courses are fairly adaptable and the subject itself tends to penetrate other areas which are habitually the parish of specialists - and specialists usually try to preserve their boundaries. The inclusion of the life sciences in multi-disciplinary programmes is primarily due to the work of the applied biologists in the late 1950s-1960s who produced a flexible curriculum which could be used in a variety of ways. Now seven or eight out of every ten students taking

a science degree in UK technical education study at least one biological subject and six or seven out of ten base most of their course on biological subjects. Taken a stage further, statistics show that the applied biology, biological science and environmental science degrees come nearer a general science degree than any thing else has in the past. It is, in any case being bought as such by students.

Moreover, the applied biologies have probably done more in the last ten years to cross the interface of science and technology than any other division of the advanced sciences. Instead of separating the components into pure and applied science there has been an attempt at synthesis, with such success that the distinction is now lost.

Undoubtedly there is an increase in the number of undergraduates studying the various life sciences. It is hoped that since they will not all get jobs as practising biologists they will have a training that will fit them better for a variety of different jobs than the mono-disciplinary courses did for their predecessors. This will be the acid test. Modularisation and grouping in courses will undoubtedly have to go still further because the essential practical objective in producing the modern life science curriculum is to develop a vehicle which is economically feasible, capable of providing a flexible variety of courses and resiliant to fluctuations in demand. This may require more sophisticated relationships between full time and part time study. Certainly, within the next year or two, consideration will have to be given to inter-relationships between technical and technological qualifications and degrees and bridging systems between them.

Many constraints prevent this synthesis, the most important being 'institutionalised principles'. People who generate these must come to terms with the facts of life which are determined largely by what the FE service and the taxpayer is able and willing to provide. The only way to deal with institutions who refuse to change their ideas is to tell them they have to generate their own resources.

TEC is likely to have an effect for practical economic reasons. Closely related, sometimes identical bodies of study will have to liaise. An interesting development is in the field of medical technology where the technology-based components of the course are taught by actual practitioners The reasons when it began in 1967 were practical. The education system simply could not afford to mount courses in haematology, bacteriology, clinical chemistry and so on, and,of course, could not afford to now. This development is significant and now being quoted as one of the best ways to run higher technology courses. TEC is now speaking of 'work experience' units, and the specialist subject of the HNC in medical technology is virtually a work experience unit - highly vocational and highly technological. Such a system saves money and brings into the programme a body of highly relevant up-to-date expertise and some training in competence to practise. Of course all FE biology will not adopt this method. But we must also remeber that some of our biology teachers are doing biology a grave disservice by their

obsession with the description of the factual and the artistic recording of intimate detail, totally ignoring the observational and analytical basis of the science. This approach makes it easy for people to regard biology as an easy option for mathematical and physical science illiterates.

Biologists in FE also suffer from their tolerance of interference from those in other specialisms, which I suspect is unparalleled in other fields. Yet at the same time we must remember that as the modern biology programme is multi-disciplinary it needs the influence of chemists, physicists, mathematicians, engineers and others if it is to work properly. They must be allowed to contribute as far as their training and experience enables them, but they must not be allowed to turn biology into a completely different subject.

There will be problems in meeting certain curriculum trends with the resources available: Firstly, there is a trend towards environmentalism. This should be concerned with the questions of what are the best technologies for man and how they can be properly managed. Secondly, there is the development of measurement and control biology. This has been built up from some rudimentary ideas on instrumentation into the study of the way in which we derive information from biological systems and what we do with it to control and modify biological systems for our own purposes. Research is needed into the degree of validity and reliability of the information we collect, how the synthesis of this information can be constructed into knowledge from which predictions about performance can be made, how these principles can be used to change and modify biological systems and so on. This field is beginning to shape up as a bridge area between the physical sciences and the biological technologies. Thirdly, there are paramedical developments. Later in the conference there will be an opportunity to discuss the pros and cons of shifting part of the present NHS training effort (embracing about 100,000 students) into the FE/HE sector. We should base our argument on whether the change will improve the standard of training and therefore the service to the patient, not simply on the fact that it will boost student numbers in FE institutions. If the change does come about the two public services involved will have to work together in a closely related way.

post-growth era

People working in environmental and economic fields are now acknowledging that we have moved from a growth to a post-growth era. If this is the case, education must adapt to the new conditions. There will almost certainly be less public money available and certainly less energy. This may affect the way people move around and will produce a change in the purpose and form of higher education. There will be changes in technologies - many will move to a more biological basis in an endeavour to find technologies which are in better harmony with the surface of the earth. There will also be changes in manpower requirements. It is rather interesting to reflect that the typical product of higher education has tended to fall into one of two categories: the scientist/technologist who is convinced that what we have is good and we should produce more; or the arts graduate who is deliberately trained to despise the technological culture as long as he is able to live on its

profits. Both of these types have been trained in the view that the primary purpose of education is to get qualifications which will bring them better standards in later life - standards which use up more resources. One of our purposes, then, should be to get the life sciences into all kinds of educational programme in order to teach the students that man is an animal species, not separate from the rest of the living world. He has his place in evolutionary time. He is also a technological animal and we should attempt to understand him so we can understand the treatments of the management of technology. I am afraid that what we do is all too often platitudinous and soporific."

Discussion Arising

The discussion which followed Mr. Norris's paper centred on the problem of dwindling natural resources. Mr. Norris commented that although there had been some 'doomwatch' warnings, people had largely pushed these fears into the backs of their minds, not mentioning the economic problems which would arise before resources actually ran out as third world countries decided to stop allowing others to exploit them. As professional educators, our role was to teach people to stop consuming so heavily. Commodities, particularly consumer durables, had to be redesigned.

Within the sphere of education, there was a need to reduce wastage. Word was circulating that unless TEC proposals could be implemented within existing resources they were simply not feasible. A member suggested that courses should be rationalised. Mr. Norris agreed, but reminded the conference that there was no merit in courses being joined together in a college where each course had plenty of students. However, if students' travel costs became too heavy, the practice of restricting biology courses to a small number of colleges might have to be changed and this would mean small numbers of students in each specialism, necessitating courses combining.

A member suggested that in view of the success of the Open University, there might be an 'Open FE College'. Mr. Norris agreed that people did not have to sit in classrooms to learn.

B Gregson-Allcott,
Education Officer,
Institute of Biology

BIOLOGICAL MANPOWER

"I propose to consider the present and future patterns of employment for biologists and those of allied disciplines in relation to the output from FE/HE and the main features of contemporary curriculum.

growth of scientific manpower

The relationship between science, society, education and training during the last 150 years of British history provides a fascinating study, with many of the discussions having a curiously familiar ring. The growth of scientific manpower over the last 50 years gives evidence of a notable change in our occupational structure.

1921	Scientists & Engineers	48000
	Technicians	5000
1971	Scientists & Engineers	480000
	Technicians	113000

In the 1800's there was no shortage of first class scientists but there was a great shortage of the plain but competent scientists needed to man the factories and research laboratories of the developing industrial revolution.

In 1881 T.H. Huxley giving evidence to a Royal Commission on technical education said that:

"the peculiarity of English science has been that the army has been all officers. Until within the last quarter of a century there has been next to no rank and file."

The reasons are clearer now than they were then. There was no underwriting of scientific activity by the state, by the educational system or by industry. For example in Edwardian England where middle class incomes were of the order of £200 - £1000 p.a. scientists - for the most part chemists - had at this time a starting salary of £25 p.a. with only a few reaching the career peak of £230 p.a. The impoverished research conditions and low rates of pay provided a disincentive to all except the unambitious or those with private means or as a subsidiary to a main career.

A fundamental new start might have been made in 1902 when the system of secondary education began to be established. But the system excluded technical instruction and by 1914 the neglect of all forms of higher education, particularly in science and technology was appallingly evident.[1]

Britain	-	FT students	9000
		Polytechnic students	4000
Germany	-	FT students	58000
		Polytechnic students	5000

Germany was particularly well endowed with scientists. They had four times as many graduates in industry in 1901 than the UK and were producing approximately 3000 engineers a year compared with approximately 500 in the UK.

At the end of the second world war it was recognised that technology had played a crucial part in the winning of the war and in 1945 the Percy Committee and the Barlow Committee found evidence of serious shortcomings in the training of technicians and technologists affecting both quality and quantity.[2]

The Barlow Committee[3] said

"It is essential that the output of scientific graduates should be increased very much above the level of expansion at present envisaged by the universities: the immediate aim should be to double the present output giving us approximately 5000 new scientists every year at the earliest opportunity."

In 1961 Sir Solly - now Lord - Zuckerman was able to pay tribute to the

"efforts which have led to such a striking increase in our annual output of qualified scientific manpower."

The Committee on Scientific Manpower calculated that there was a prospect of 20000 scientists by 1965 and 30000 by 1975. Zuckerman predicted that by 1965 supply and demand of manpower should not be out of balance and that a surplus may exist after that date.

Such developments were welcomed, for this surplus manpower could be deployed rationally into management, administration and the professions generally - in a system hitherto typified by amateurism.

Despite these forecasts two other Committees drew attention to the neglect of science. Dainton, 1968, drew attention to the drift from science in the sixth form and the Jones Report on the brain drain advocated greater national devotion to the creation of wealth through science, 'rather than its distribution and consumption'. Indeed the 'white hot technological revolution' of Mr.

Wilson's (1964) administration had four basic assumptions. It was proposed to train more scientists, to keep them in the UK, to make greater use of their talents and to create wealth through the application of science. In 1968 the Swann Committee emphasised a further dimension in the examination of scientists and technologists. What industry wanted was 'more science - based generalists and fewer science based specialists'.

In 1963 the Robbins Report reviewed the pattern of full-time higher education in Great Britain in the light of national needs and resources. They arrived at a requirement of

390 000 student places in FT HE in 1973-74

560 000 student places in FT HE in 1980-81

The Report also recommended that Colleges of Advanced Technology should be given charters and the creation of a Council for National Academic Awards.

In 1966 the White Paper 'A plan for Polytechnics and other Colleges' proposed the development of 30 polytechnics and changed the four tier system which had existed in Technical Education since the White Paper of 1956.

More recently the Hudson Institute report on Britain claimed that too few students are being educated and attacked the Robbins 'student - demand' principle of higher education expansion. The report claims that the development of higher education must be geared to the future needs of a technological society.

There are great difficulties in assessing student demand for places in higher education and conflicting arguments make realistic assessment problematical. Many assume that students and school leavers carefully calculate their job and salary prospects before embarking on degree courses. This view is challenged by others, particularly appointments services, which claim quite the reverse. Nevertheless, the average starting salary for science and technology graduates has worsened with respect to the average wage of an adult male worker. In the early sixties these wage and salary levels were approximately the same but by 1972 the graduate was 30% behind.

M. Blaug and K.G. Gannicott have criticised the contradictory arguments of various official reports and regard their claims for the expansion of science and technology as special pleading of the science and engineering lobby which was out of all proportion to the quality of their forecasts. One point, however, on which most of these commentators of the recent past agree is that the British curriculum probably was out of date. This year there has been a boom in demand for science and technology graduates and while the long term trend will be for graduates to seek employment in areas which are not 'traditionally' those of graduates, this boom has indicated how little is known about demand for graduates.

biological manpower

The recent mixed fortunes of graduates in the employment market has not affected biology graduates as much as other science graduates. It did create a situation where people started asking pertinent questions - perhaps in contrast to earlier euphoria about the place of the graduate in society. In order to get the right answers, the right questions must be asked. For example 'Is it possible to plan the output of graduates?' or 'Do we get the right sort of graduate?'

The situation is biology must be put into the context of the total commitment to HFE in this country. It is preferable to make a simple division of our education service into two major areas.

Firstly, the contracted area of education. This includes courses which are related to particular industries and the fluctuation of student numbers depends on employment within those industries. These courses include medical, veterinary, dental, pharmacy and bio-medical full-time courses and part-time courses such as ONC, HNC and MIBiol. Secondly, the non-contracted or speculative area of education. The needs of any particular industry is not reflected in the numbers of students on these courses which include all other full-time courses in HFE. It is largely social factors which determine the numbers of students on these courses.

As Gareth Williams says one significant factor is the 'willingness indicator'. In 1968 87% of leavers with good 'A' level grades went on to degree level courses or teacher training. In 1973, in spite of empty places, the corresponding figure was only 80%. Many of these students could have had the pick of degree courses. Williams concludes that while the DES target of 600 000 students by 1981 may represent an unduly gloomy view of the trends - the 750 000 planning target of the 1972 White Paper, 'Education: a Framework for Expansion' greatly over-estimated the demand for education, at least on the traditional criteria of provision.

Graduates in the speculative area of education are not produced in relation to the needs of industry or the economy as a whole but in direct relation to the needs of the student and those who teach them.

The majority of students are in this area of education and the education service is thus a product orientated industry rather than a market orientated industry. One cautionary note for biologists is that the education service is the biggest consumer of its own products.

definitions of biology

Even the Institute of Biology finds it difficult to determine how many biologists there are in the country. One of the difficulties is the diversity of biology and the consequent problem of defining just what a biologist is. The Council for Scientific Policy: Working Group on Biological Manpower[4] surveyed six aspects of the problem of finding a balance between supply and demand for graduate biologists.

These were:

(a) definitions of biology;
(b) intake of biologists;
(c) distribution of biologists;
(d) possible changes in demand;
(e) possible control of supply;
(f) suggested changes in education.

The Working Group arrived at a comprehensive definition they called 'total biology'. In contrast, biology as defined by the Population Census 1960, the Triennial Manpower Survey 1968 and the University Grants Committee 1969 excludes Agriculture, Biochemistry, Medicine and Dentistry.

The Working Group concluded that medicine and veterinary studies should be included and obtained data from the Research Councils, Government Departments and industrial firms during 1969 and 1970. Other sources of employment not listed are universities (3300 biologists in 1968: TMS survey) and non-university teaching posts (5000 biologists in 1968: TMS survey). These TMS surveys exclude agriculture, biochemistry and medical and they underestimate the true numbers and taking all these omissions into account the Working Group concluded graduates engaged in 'total biology' would number 22 000.

distribution and changes in demand for biologists

The Working Group noted the following changes in demand for biologists:

1. Universities. The number of biology graduates on university staffs had been increasing by 11% per year; this includes about 30% of the Ph.D output who are retained on the teaching staff. Indications were that the rate of growth would fall to about half of this value.

2. Further Education. In further education establishments the overall rate of increase in biology graduates from 1962 to 1967 was 9.2%: in actual figures 340 to 540. It seems probable that in polytechnics and technical colleges the fall in the rate of growth will be less than in universities.

3. Schools. The rate of growth in graduate biology posts was 4% compound, i.e. an increase of 50% by 1980. There appeared to be 10-15% too few biologists teaching in schools and there are still many school staffs that do not include a biologist.

4. Government Service. From 1965 to 1968 the increase was 5% compound. It was thought to be unlikely that the permitted growth rate will increase.

5. Medicine. It is recommended that the annual intake of British resident medical students should rise from 2,430 in 1967/8 to 5,000 by 1989, the rate of growth being highest in 1970-74. This would necessitate more non-medical biologists for teaching and research in the medical schools. Ancillary services in hospitals and public health would also need increases in graduate biologists. (The population census of 1966 showed 2,800 biology graduates in medical and dental service).

The main growing points were expected to be immunology, virology, endocrinology and genetics.

6. Industry. Graduate biologists in industry increased 5.7% per annum from 1965 to 1968. From 1969 to 1974 the estimated overall increase is 35%. The major developments were expected to be in all aspects of pollution studies.

wastage

A mean working life of 40 years implies a steady-state wastage of 2.5% per annum. Other sources of wastage are death, emigration, change of employment and (for women) leaving work to raise a family - these factors would add approximately 1%. The Triennial Manpower Survey showed a wastage of 3.2% but there are wide variations (from minus 5% to plus 9%) in individual sectors of employment. In 1971 the rate of wastage was below normal - probably less than 2.5% - because of the preponderance of young biologists available for employment. The only available figures for the calculated demand for biologists are those of the Triennial Manpower Survey, which are unsatisfactory because they exclude the highly important subjects of biochemistry, agriculture, medicine and the health services. The TMS figures, obtained by adding 3% annual wastage to a 5-7.5% annual growth, gave a demand for 700 graduates with a first degree, plus 275 with higher degrees, per annum. The 1968 supply figures (also from TMS are 1910 with a first degree and 525 with higher degrees). These data might be taken to indicate that there was a substantial excess of first-degree biologists and a smaller surplus of those with higher degrees. However, it would be dangerous to reach too firm a conclusion from the TMS figures because the information supplied covers only about half of those included in 'total biology'. Clearly, a much fuller coverage is necessary if the manpower position in biology is to be kept under constant and effective review.

The latest TMS survey[5] (1971) shows no significant changes overall between the surveys of 1968 and 1971 but consideration of the detail reveals that the proportion of scientists in research institutes has fallen from 11.4% to 9.9% even though the number has increased in absolute terms from 1189 to 1414. The offsetting falls have occurred at the expense of other employers.

The survey also shows that the proportion of scientists in education has fallen from 29.2% to 27.8%. This obscures the fact that while the number of scientists employed by universities and colleges has remained unchanged at 3061 those employed by local authorities have increased from 3641 to 4242. Schools appear to have benefitted from the increase.

The Working Group listed the UGC figures for unemployment for 1965, 1967 and 1969 and I have extended them to 1972[6]. No such data exists for CNAA graduates and great significance should not be read into these figures. Nevertheless the Working Group concluded that in future the possession of biological degree must no longer be regarded as an automatic passport to a career in biology. However they did not consider that a calculated restriction of university places in biology should be imposed, as there is no satisfactory way of deciding on a target for the output of biologists.

The view that there must be changes in perspectives of science graduates was supported in the Department of Employment's Manpower Papers No.8 'Employment Prospects for the Highly Qualified'.[7] Quite rightly it concluded that higher education would not cease to be a route to the top in occupations such as scientific and technological research, medicine and teaching but that an increasing proportion of new entrants to professions such as accountancy or librarianship would be graduates. This is not a new phenomenon since our industrial society and educational system has been in a continual state of adjustment for the last 30 years. For example, over the ten years from 1962-72 graduate recruitment of executive officers to the Civil Service rose from 5% to nearly 25% of total recruitment.

Preliminary figures from the Department of Trade[8] indicate that the curve of the population of biologists increased steadily until 1966 after which it steepened. In 1959 there were approximately 17 000 qualified in biology and this number had doubled by 1970. In the same period the number of first degrees in biology had almost trebled.

Studies of biology graduates or equivalent in employment must start from the economically active population. At the 1966 census this was taken at 73% of the total of qualified biologists. The projected figures indicated that the total population of biologists is as follows

1961	19 577
1971	38 660
1981	73 700 or 78 300

The first figure for 1981 assumes that there will be no further increase in the new supply of biology graduates or equivalent after 1974. On this basis the projected figure is 73 700. If, however, the 1971 to 1974 increase of 5% per year were to continue then the population by 1981 will have risen by an additional 4 600 to 78 300. Whichever figure is taken for the population in 1981 it is likely to be approximately twice that in 1971. This means that the economically active stock of graduate biologists in 1981 will be between approximately 55 000 and 59 000.

demand for biologists

There is no satisfactory way of gauging demand for biologists. Even surveys are little more than guess-work but an attempt has been made by I.Y. Caldwell and A.J. Dent[9, 10] of Queen Elizabeth College, London. They surveyed the advertisements for graduate and technician biologists in 'Nature' and 'New Scientist'. The details of these surveys can be found in Biologist and the figures they give will be comparative rather than absolute because they did not include other media, such as specialist journals and newspapers, in their survey. Nevertheless, the summary of their figures provide an interesting distribution of jobs. In the job market the university and polytechnic graduate will compete on equal footing but it is significant that in a recent survey conducted for the Committee of Directors of Polytechnics for 1973 graduates indicates 68% took up posts in industry or commerce compared with 50% of university graduates and the proportion of Higher National Diplomates going into the same fields was as high as 84%.

Dr. Webber conducted a survey of the first employment of 1972 Biology graduates from Polytechnics for the Institute of Biology's Committee on Demand for Biologists. This indicated that out of a total of 248 graduates from 10 polytechnics:

84	(34%)	entered biological employment;
17	(7%)	entered non-biological employment;
100	(40%)	pursued further study;
8	(3%)	were unemployed;
39	(16%)	were not traced.

a case study - ecology

The current awareness of environmental problems has led many students to consider seeking qualifications with an ecological bias. What hope is there that they can match their interest with the hope of a job in the future?

A survey by the Institute of Biology in 1970[11] indicated that there were 272 posts in the Government Service for ecologists/general biologists and 257 biologists employed in organisations concerned with water resources.

A more recent survey has been conducted by Susan Carter[12] who questioned potential employers and past members of M.Sc. courses in Conservation, Ecology and Environmental Resources. Her aim was to attempt to assess the nature of employment and possible future demand for ecologists. Her tables of results are too detailed to reproduce here but she lists the role of ecologists under different fields of employments under the following headings: Planning; Landscape Architecture; Other Consultants; Water; Industry; Research; The Voluntary Movement; Museums; Education. She concludes that any attempt to balance the supply and demand of ecologists is frustrated by the difficulties of describing an ecologist in terms of either his qualifications or his work. Neither ecologists nor their potential employers seem certain of the contributions ecologists might make to the work of existing institutions.

However, one important fact that must be borne in mind is that in assessing the future demand for ecologists it is not only the growth in jobs but also the turnover of the present posts. For example the Government in 1972 employed a total of approximately 3000 biologists but the turnover was about 4% of the total. Taking the Working Groups figures this means that the total number of ecologists employed by the Government in 1972 was approximately 10 - an insignificant number compared with the total number of ecologists produced.

employment prospects for ecologists

The changes in the structure of courses and in the attitudes of students to their courses will inevitably mean that there will be people who are not satisfied with the traditional role of ecologist. In an investigation of the possible areas of employment there seemed to be a reasonable split into two groups of people. Firstly those who biological education leads them to want to work as a biologist in an applied field. These are people whose biology is useful to them in the employment sense and meaningful in the professional sense: they can obtain M.I.Biol. after suitable experience.

Secondly there are those whose biological education gives them a broad background to the biological problems of society and who want to work in areas outside those of applied biology. In order to become qualified these people have to pursue other courses and become members of other professional bodies. They are therefore people whose biology is useful but not meaningful in a professional sense.

The provision of 10 all purpose Water Authorities has created a career structure within the area of environmental control which will enable a person with the right academic and personal qualities to move into an administrative capacity which at its highest point, will surely be equivalent to a top Civil Service appointment. Biologists and ecologists could play an important part in this structure. Over the last five to ten years the River Authorities and Water Boards have used biologists in roles which were traditionally those of the chemist or engineer. The increasing employment of biologists at the lower levels will create a pyramid structure which may enable a biologist to be considered for top appointments alongside chemists and engineers.

It will be important, however, for the biologist or ecologist to learn another trade and here the original classification must be returned to. The second group were those whose biological education was useful but not professionally meaningful. The Royal Town Planning Institute, the Institute of Water Pollution Control, the Institute of Landscape Architects and the Association of Environmental Health Officers are all examples of professional institutes who could accept an ecologist only if he were prepared to follow a course leading either to their examinations or to a recognised exemption from their qualifications.

Contacts with a number of people from universities, professional institutes and local authorities have convinced me that a specialist ecologist is unemployable in the fields such as town planning, water resources, urban conservation, landscape architecture, unless he has a second qualification related to the technology of one of these fields. Indeed the present attitude seems to be that when there are sufficient applicants with an initial training in a discipline related to the job, they would be considered in preference to those who had an ecological training and who wished to start or were part of the way through a second training.

future problems

(1) Increasing numbers of graduates from HFE

The projections of the Department of Trade discussed above give an indication of the size of the problem. There may be considerable scope for retraining courses at all levels. Indeed the Institute of Biology is considering a possible Postgraduate Diploma in Environmental Science and Engineering. Should this joint CSTI/CEI venture be successful it will allow for retraining of biologists and engineers in the problems of environmental monitoring.

(2) Increasing numbers of full-time students at below degree level

The general trend is for a decrease in part-time and an increase in full-time students at below degree level. The figures for the Higher National Certificates and Diplomas in biology do not follow this pattern strictly, but this trend will be accelerated by the Dip.HE. The Centre for research into Environmental Monitoring at Chelsea College, London is seriously considering environmental monitoring courses for technicians at Dip.HE level and many other colleges are considering including biology in Dip.HE courses.

(3) Major changes in the supply, type and studies for technicians

It is possible to identify different levels of technicians

(a) Technician/Technologist
(b) Semi-skilled Technician
(c) Laboratory Aid/Craftsman

At present National Certificate and M.I. Biol. courses cater for the top grades and CGLI courses for part of the other groups.

The HNC in Applied Biology seems to be maintaining constant numbers at around 400 - 450 examination entrants per year. This is in contrast to other science subjects which, except for computer studies, are falling and in contrast to M.I.Biol. by examination numbers.

The maintenance of HNC in Applied Biology student numbers depends on a complex interaction of factors but they include:

(i) Course structure - firmly based in measurement biology with specialist options.

(ii) Recognition of the role of the skilled technician in the biological industries.

(iii) Salary - usually as good as or better than graduate.

(iv) Adverse publicity about graduate employment.

To some extent M.I. Biol. by examination suffers because of this. Many employers will not allow day-release beyond HNC and the promotion and salary expectations of M.I. Biol. students do not receive sympathetic consideration from their employers.

One problem which is usually overlooked in the consideration of examination entrants is that of the numbers of students who drop out during the course. The figures for the HNC in Applied Biology have been used only as an illustration of a situation that is a major problem throughout HFE and in calculating the costs of education to the country it is surely one factor which ought to be taken into account. Perhaps the course structures as proposed by the Technician Education Council will alleviate this problem as well as providing a versatile approach to the training of technicians. However, the

advantages that TEC would claim for its approach has yet to be justified in practice and as far as applied biology is concerned is a long way off.

(4) Industrial Training Boards

The industries associated with health, food and the environment are becoming more complex and it is necessary to have a skilled and responsible manpower. Vocational education is concerned with learning in the environment of the job and the association of the relevant educational background for practical purposes.

The Training Services Agency [13] will oversee an expansion of industrial training. Retraining such as the Training Opportunities Scheme (TOPS) will not guarantee that men who are out of work can be placed in jobs but it will be an important way of helping those whose skills have become redundant and who, if they find work at all, will have to change their jobs. At present few science courses are influenced by Training Board programmes but it is clear that in the future the Training Boards and FE will be partners in vocational training programmes.

fitting students for new roles

Students must be fitted for new roles in the future and the control of this process is in the hands of the teachers and administrators. The following factors should be considered:

(1) Vocational - supply of trained manpower

(2) Economic - proportion of GNP that can be devoted to HFE.

(3) Social Factors - interest and motivation of students.

(4) Educational - what is learnt and how it is taught.

Biology is a subject where there can be a reasonable compromise between the inter-reacting factors and the education service has been able to supply manpower in a rapidly expanding employment situation. This situation will not continue but it is worth commenting that in factors (1), (3) and (4), FE has led rather than followed other sectors of education. Many university courses in biology would seem to be anti-educational despite what is claimed for them and most do not satisfy a vocational criterion - unless that criterion is one of carbon copy reproduction. The viscious circle ad nauseum.

However the situation in HFE is changing so rapidly that plans for change ought to be well advanced. These should include:

(1) Consolidation and diversification of the role of HFE. The ITBs will be involved here at all levels.

(2) Development of efficient curricula. Many courses all concerned with same area of work seems ridiculous.

(3) Work on the basis that knowledge is inter-related. This is the measurement technology aspect of applied biology. The differences between pure and applied biology are attitudinal and operational. Measurement biology makes use of various aspects of other sciences.

(4) Recognition of the fact that society is dependant upon a complex technology which is changing and diversifying. Higher education cannot afford to produce people who are not able to accept the challenge of a changing technology.

costs of education

Up to 50% of the appropriate age group entering higher education is envisaged by some commentators. Can society afford to pay for this?

Professor Mark Blaug says that planning and policy making in education cannot rely on manpower forecasting. He concludes that it does not appear that manpower patterns can be predicted ten years hence with the degree of accuracy required by educational planners - it has on occasion been positively misleading.

Geogre Psacharopoulous compliments Blaug by arguing against educating people to specific long-term manpower requirements and calculates the economic returns of education to both individual and society.

output budgeting

Output budgeting identifies components of cost: Capital and Maintenance; Teaching costs; Administrative, Library and general facilities.

The results of the calculations varied widely at the University of Bradford for the academic year 1969-70 for educating students to first degree level [14]:

Science or Engineering	£2509	- lowest
	£3991	- highest
Social Sciences	£1632	- lowest
	£2386	- highest

The costs were even more disparate when administrative costs which apply to all students were removed.

Science or Engineering	£1650	- £3200
Social Sciences	£650	- £1250

In 1966-67 [15] the direct cost for one year's university education was about £1075 and the indirect cost of earnings foregone was about £700.

Public funds paid for about 90% of the direct cost and the capital cost but by contrast students carried most of the earnings foregone; average maintenance grants in UK being £270. Adding together the average annual subsidy of a

university students' education it comes to £1250. This may be compared with the manual workers average wage of £1050 in 1966-67. Of course, using today's costs these figures would be approximately doubled. Taking the overall rather than direct costs the higher expenses of educating a university graduate in science seems not to be compensated for by the money value which society places on their services.

Economies can be made by:

(a) worsening of the staff/student ratio;

(b) reduction of 20% in contact hours. This caused average cost reductions of 5%;

(c) reduction in number of optional choices on courses.

No economies were found when:

(a) tutorial classes were replaced with lectures;

(b) class sizes were increased by 60%.

Low level of use: laboratories were used 40-46% of time on 32 hour week during a 33 week teaching year. If laboratory use went up to 80% of time on a 32 hour week total costs were reduced by between 7 and 19%.

planning projections

The Robbins Report noted that the estimating numbers of places could be done in one of two ways: by considering the supply of educated people for the needs of the nation, or by considering the demand for higher education places.

The Committee rejected the first and considered the second and concluded that there was no reliable basis for reckoning the totality of such needs over the long term.

Nevertheless, it is frequently suggested that such manpower forecasts should be made. This could be done by either taking an agreed economic plan and breaking it down by sectors and by industries and calculating the labour force to produce this output, or by asking employers to estimate their future needs assuming a given rate of expansion.

The first depends upon labour/output co-efficients and occupation/education relationships. Estimates using the second method are liable to perpetuate or even amplify present divergencies. In any planning model the social desires of the individual must be satisfied and these are less quantifiable than those of manpower planning.

The notion that the private demand for places in education will adequately reflect the economy's demand for manpower is dependent upon a number of stringent assumptions and also the proposition that we now have the right

amount of manpower for our general level of economic development. This last is a point that many would dispute and it has become fashionable to say that the UK is educationally under-developed compared with her major competitors. As producers of professional technologists the UK was marginally behind France but ahead of Germany in 1964 [16]. If levels of training analogous to HNC are included then the UK led the non-Communist world. The figures include a large component for the engineering HNC courses in the UK. Since 1964, however, the Engineering Institutions have altered their attitude to the HNC as a route to professional qualifications and there has been the current boom in the biological sciences in HFE.

Perhaps there is no quantitative problem. Could one reason for our current problems be that technologists have failed to penetrate the Establishment in anything like the depth achieved in other countries?

conclusions

The assumptions which influenced HFE during the last 50 years were the supposed shortage of high level manpower; the apparent relationship between manpower and technological advance; and between technological advance and unstoppable economic growth. In present circumstances these assumptions are not valid though some studies have indicated a tenuous link between technological advance and the generation of new wealth. HFE must be judged on its academic and technical merit.

Nor can we assume that HFE is a 'good thing'; that full-time HFE is the best way of producing scientists; that part-time HFE is of lower academic level and inefficient; or that society will continue to underwrite massive expansion of HFE.

What is needed is a greater mobility between FT and PT with interspersed years of training. HFE is potentially able to produce 10 times the number of graduates than are necessary and the restraints are the rate of absorption of manpower in industry and the costs of industry. It is also certain that these restraints will increase in the future.

To some extent biology will be insulated by the fact that there will be expansion of the technologies related to food, health and the environment; that there will be a need for well trained technicians in vocationally and financially attractive roles; and that biology has taken the role of a high level science education."

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Discussion Arising

laboratory usage

A member commented that while the figure of, for example, 45% usage of laboratory space seemed low, it was not in fact that bad since the number of places occupied as well as the number of hours a laboratory was used were taken into account. With such a method of calculating, it would be impossible in most circumstances, to get a figure much above 60% usage.

IWPC

It was suggested that the Institute of Water Pollution Control's courses would be an ideal opportunity for biologists and engineers to work together. Mr. Gregson-Allcott replied that a joint working party between the two Institutes had been set up. The IWPC insisted upon honours degrees as an admission qualification and had not accepted the M.I. Biol. by examination as an equivalent qualification. The IWPC provided the syllabus and the examinations and their pass rate was low. The IWPC was controlled by sewerage and water works managers whose qualifications were in engineering, and it was

therefore difficult for biologists to be accepted. The only hope was that time would bring an improvement in the situation.

NHS demand

A participant expressed the fear that the NHS demand for biologists would flatten off in favour of electrical and mechanical engineers because of the importance of appliances. Mr. Gregson-Allcott thought this was unfounded - since engineers and biologists had different functions in the NHS although both could benefit from paramedical courses.

new fields of work

Members suggested food technology as a new area which might employ biologists. Mr. Gregson-Allcott was asked whether there were any increased opportunities in the field of ecology now that it had become a fashionable subject. He had no evidence for this. People who were now called ecologists were often simply termed biologists in the past. Several members commented on the huge numbers of enquiries they had from school leavers attracted to marine biology and the fact that there were few jobs available. They agreed that the best solution for such applicants would be to take a more general course so that they could enter other fields. There were, however, jobs for biologists where special knowledge was applied to aspects of marine biology, e.g. toxicology.

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THE PLACE OF LABORATORY WORK

"Until now, biologists in Further Education have tended to be pioneers. It is 18 years since the biologists in technical colleges first got together on a short course on Further Education biology. This was a "taught" course, with speakers from, for example, universities who claimed that there was no future for FE biology other than in the provision of longer, bigger and better courses for GCE 'A' level and external London B.Sc. But one member of the course, a Mr. Norris, who was then a lecturer, protested, and from that point, carried the conference with him.

a time for review

Perhaps the stage has now been reached at which Further Education biology has come of age. Initially conferences on Further Education biology were trying to justify the fact that there was a place in Further Education for biology, that it was not just 'jumped up' 'A' level or watered down B.Sc. We started from scratch with conferences on the curriculum - we devised quantitative biology. Then we discussed the organisation of courses - day release, block release and so on. We followed this by turning our attention to assessment. Now we seem to be concentrating on fine administrative details and the missionary zeal which we once possessed seems to have been taken over by the mathematicians. Perhaps these administrative details should be left to administrative officers. Perhaps we should now pause and review what has been done in the name of Further Education biology, consider whether some of it has been worthwhile and contemplate what the next stage should be.

In this paper I shall raise a number of questions concerning approaches to laboratory work and go on to make some points concerning the organisation of laboratory and practical work.

Approaches to Laboratory and Practical Work

(1) What is the philosophy and purpose of such teaching periods?

Do we have them because staff enjoy it, because students enjoy it, for expediency, to impress external examiners, or because universities do this type of work? Are we concerned merely with justifying ourselves to others? Should we perhaps be doing something else instead? Why, for example, do we continue to "teach" dissection, the artistic display of animal guts? Not very many teachers have stopped, yet the only justification they can offer is

the fact that they did it themselves when they were at university. I asked a large number of FE biologists what they believed was the purpose of the practical lesson. Their replies included the following: to inculcate skills; to instill the need for accuracy (or an appreciation of it); to evaluate results; to record and present results; to teach a tidy, logical, organised approach to problem solving; and to expand theory lessons.

Let us consider these responses. Can we really teach any kind of worthwhile skill, relevant to present day applied biology, in the time available for practical work on any biology course? Should we perhaps select just one or two skills and concentrate upon these? Or should we go to the other extreme and create courses which are an extension of existing elementary courses and intended purely for skills training? In any case, how many biology teachers have any real expertise in skills training? A tremendous amount of work is done by staff in teaching skills at craft and operative levels, yet we attempt to teach a number of complex skills in far less time and with far less expertise. There does not seem to be any easy answer to this problem. A few years ago it seemed possible that it might have been solved by the involvement of the Industrial Training Boards, but this has not come to fruition. If we do decide that we ought to continue to teach skills, how do we set about it? Do we have a meeting to decide on which are the essential skills for a biologist? At present, it is quite easy to find students being assessed on their ability to produce an artistic drawing! Is this the skill?

How far is it true that accuracy and appreciation of accuracy derives from pratical work? What do we really mean by 'appreciation' - it is possible to appreciate a painting simply by looking at it! What sort of accuracy do we expect? The accuracy we demand of a 16 year old school leaver is not the same as the accuracy we would expect from an HNC student who has been in charge of, say, spectrometry for the past five years? Should we, in fact, be using practicals to teach or monitor accuracy? The improved recording and presentation of data is one of the arguments college staff use to persuade their paymasters to give them expensive equipment, which in fact, often gathers dust in a corner, once acquired. Practicals are often carried out simply to justify the possession of such equipment. Perhaps we should ask whether we really need the same apparatus in every college. Might we not pool our resources so that colleges share equipment? I know I am preaching heresy, but it is quite possible for a successful HNC course to be offered with very little equipment being used in the college itself.

The suggestion that practicals teach problem-solving is nonsense. The number of students produced from Further Education capable of solving any kind of problem directly concerned with what they have been studying is minimal. While we ought to try to teach problem solving, we have not yet developed the necessary techniques - and I have certainly seen little evidence of problem solving being taught in practicals. Could practicals be designed specifically to do this?

Finally, there is the suggestion that practicals are necessary in order to expand the theory lessons. Yet FE biology has had an information explosion. We thought 18 years ago that it would be difficult to gather together enough material to teach, but there is now a mass of theory to be taught so it is very dubious educational philosophy to suggest that practicals should be carried out in order to expand the theory. People in our society have got the information (or can get it very readily) but do not know what to do with it after they have been given it.

(2) Do we ask students (or ourselves) to think about laboratory work as much as we could (or should)?

We tend to concentrate on discussing theory. Perhaps we should involve students more in the consideration of what should be done in practical work. This is specially important with more mature students on day release.

(3) Do we vary our approach according to the needs and attitudes of the various (and varying) students and classes?

One of the most interesting arguments to emerge recently is that modules would enable us to cater for the needs of different types of student. Many of us tend to assume that the students in a class are all the same, or that they are the same as we were when we were students. I suspect that we make too little use of their different abilities or motivations. Of course, we could not easily devise a programme individually suited to each student, but we must remember that the students do differ. Perhaps we could use students who are experts in various areas - often more expert than the lecturer - to teach as part of a team.

(4) Do we kill enthusiasm by our approach and instruction?

Here again we must remember that students differ and that we can kill the enthusiasm of most people in a class by making them all do the same thing, at the same time and at the same rate (and in the same place).

(5) Are there dangers in the 'find out for yourself' method?

This was hailed as a great breakthrough four or five years ago and lecturers worked hard to produce "project" material which in the event often failed to raise a flicker of interest among the students. Alternatively, students often got so enthusiastic that they delved into the subject way beyond the level of the teachers' knowledge? We have to ask ourselves whether this is desirable. If so, how do we channel it and design for it.

(6) Are laboratory periods organised on the grounds of education or expediency?

All too often they are arranged to give a teacher a 'rest' from a heavy teaching load which, while understandable, is by no means justifiable. What are the educational objectives in practicals?

(7) What constraints prevent the integration of theory and practice (or education and training)?

The constraints which biologists point to now are totally different from those they mentioned ten or fifteen years ago, and are mainly such matters as the size of laboratories or timetables which I would identify as merely organisational constraints.

(8) Do we use practical periods to educate students in skills other than biological ones?

Written reports are frequently judged to a fair extent on the standard of the English? Is this as it should be? Perhaps we should decide on the use of report preparation methods which do not involve the use of English to any great degree, e.g. punch cards and tapes. What does industry do?

(9) How will the practical work be assessed?

Is there a case for adopting new methods, such as the approach used by the paramedical services which includes assessment of the ability to interact with others, e.g. the approach to patients, personality profiles, case histories.

(10) Do we integrate with outside bodies involved in practical training?

The Chemical and Allied Products ITB, for example, has material which might be very useful to us, e.g. their Training Recommendation No. 17 Supplement B concerning the training of laboratory technicians in biological science and Information Paper No. 14 on basic instructional methods. We are surely not a 'closed shop' and do not have a monopoly in education.

The Organisation of Practical Work

The following points might be worth consideration. They are mainly 'common sense' but useful as a check list.

(a) We should plan ahead much more not merely for one part of our syllabus.

(b) We should reconsider seriously the time allocation. More flexibility is needed. A number of firm's training schemes structure practical work so that students begin and end at different times. It may be that some students can complete their work satisfactorily in less time than others and they should be permitted to use up the excess time on other work. "Flexi-Time" is with us!

(c) Are the exercises progressively difficult for the students? In theory we attempt to ensure that they are, but all too often this means simply that they are what the teachers regard as progressively difficult and not the students. This is due to the mixed expertise and backgrounds of the students and is one reason for the attractiveness of modular course structures.

(d) What level and amount of instruction will be required? Students are often given a surfeit of instruction - a bulky hand-out when a few pithy notes would

suffice. It is not unusual to see practical instructions taking far longer than the actual practical. Can industry and business help us here?

(e) Is supervision needed and if so to what degree? Many people feel it is imperative that students are supervised, that they will do no work unless they are watched. Yet many part-time students are quite accustomed in their full-time jobs to working unsupervised. Although safety precautions will have to be sorted out allowing students to work unsupervised would help colleges solve some of their time-tabling and student-staff ratio problems.

(f) How will the class be grouped? Students in practical sessions are often divided into groups. Should they be allowed to form groups with their friends, or be split up according to their abilities? Should we use students with certain skills to teach them to other students in the group? The dislike of using students as 'unpaid demonstrators' is quite illogical. They could form an important and integral part of industry based practicals.

(g) Will everyone do everything? Who does what? At what stage?

(h) Is the 'teacher' involved? With whom and at what stage?

(i) What will be the report format, if any? Should we develop new methods, as other fields of science teaching have done, such as algorithms, computer and data processing?

(j) Consider an Assessment Profile for each student, his progress, his good skill/ability areas, his poorer ones.

(k) Was the exercise worth it? We can only know this if we first set objectives and then measure our success against the achievement of these objectives.

It is important that the people involved in Further Education Biology find the solutions to these issues, for if they don't, others, for example, university external examiners may try to do so, and the result could be an authoritarian, "academic" approach which has nothing in common with the wholly exciting, rewarding and useful aims of Further Education.

Discussion Arising

application to biology as a whole

The comment was made that just as practical work could be examined in the way Mr. Young had suggested, so could theory. The danger was that it might be destructive. Although it was a good idea to question why things were done, one might reach the stage of believing that nothing that was done was justifiable, yet not know what to put in its place.

skills and techniques

It was suggested that the way to examine the validity of practical work was to consider not what was done but the way it was done - i.e. the skills and techniques that were learned. It should be remembered that the techniques a student needed to learn varied according to the type of employment in which he was interested. Replying, Mr. Young said that there were many elements in the teaching of Further Education biology which did not seem to have any justification but were present by tradition.

equipment

On the question of expensive equipment which did not get much use, a member said that this was not entirely the fault of the college. Often they were forced to acquire such apparatus by validating bodies who thought it was necessary. Members agreed that equipment should be shared by colleges. (Transport was cheaper than some equipment.) This led to the proposition that prepared teaching materials should also be used by more than one college and the suggestion that the sale of such material ought not to be regarded as unethical. It was suggested that students were able, quite often, to devise their own equipment which would give satisfactory results. Often it was assumed that only high level students could do this, but it had been done quite successfully with first year agriculture students.

mixed student groups

The likelihood of there being an increase in the number of classes containing students of mixed ability was raised. This was not seen as a great problem by members who had experience of mixed student groups. It was felt that oten students of different types were able to learn from each other.

A J Branton, Architect, and F Drake, Furniture Designer, Laboratories Investigation Unit, Department of Education and Science.

LABORATORY DESIGN

The Laboratories Investigation Unit was set up in 1967 under the DES and UGC in order to study design problems in laboratories and carry out development work. Tony Branton and Frank Drake, whose work for the Unit is concerned with research and development into furniture and services, spoke to the conference in a session which preceded a visit to the site of the new laboratories being built at Bristol Polytechnic. Their main emphasis was on the need for adaptability, in view of the fact that laboratory needs are constantly changing.

investigation

Mr Branton and Mr Drake described the careful investigation of existing and past laboratory usage in universities, colleges and schools which was made by the LIU. They used straight time lapse film of spaces in use by all types of people - lecturers, technicians, students, cleaners and so on. Structures interviews were carried out, which covered pre-determined subjects but allowed people to speak about anything they regarded as important, in whatever way they liked, but yes/no questions were not used. The team carried out searches into anthropometric and ergonomic information available to industry and education to see how people were trying to manage goods, materials and resources in other fields and compare these with the methods of management and distribution of goods and materials in education. In this way, enough information was gathered for patterns to be identified.

past developments

The changes which had taken place in laboratory design over the years were examined, beginning with the era before electricity when the only source of energy was in the form of portable lamps. This was a period when the laboratory really was in the hands of the user. However, when people had to be educated in larger groups, things were rationalised for a number of reasons. Partly because the lectures were divided into two types of activity, an address and a practical exercise, and the two could not go on in the same place, partly so the lecturer could patrol around, and partly due to the fact that the distributing of piped energy at that time had to be achieved by attaching it firmly to furniture which in turn was firmly attached to the building structure. This led to the development of the classic formal laboratory situation, which forever afterwards stamped the pattern of laboratory design for successive generations.

The LIU team analysed how people used spaces irrelevant to the objects in them, ie. analysed them territorially. By noting the territories of workers, the overall shape of the space and the shared territories it was possible to see whether the fixing of the furniture, its layout and the shape of the space related to people's behaviour. Detailed consideration was given to services, sinks and worktops and storage facilities.

reasons for change

The LUI found that a combination of a number of factors produced the need to adapt facilities[1]. These included:-

a) growth - the increase in staff or students or the introduction of more equipment,

b) changes in personnel - newly appointed staff may wish to alter layout to bring it in line with their personal approach to research or teaching,

c) developments in experimental techniques - this may involve the introduction of new equipment, the relocation or removal of existing furniture and equipment, or the introduction of new services,

d) changes in teaching methods - increased variety of work, changes in group sizes and the balance between individual and group work can demand new layout,

e) administrative management changes - the need to use space more effectively can lead to the adaptation of teaching laboratories for multidisciplinary use, which in turn creates problems of storage and servicing.

developments

"The principal objectives of the Unit were to develop a flexible system of laboratory furnishings and servicing which would enable layouts to be altered, without the need for specialist contractors, by the users themselves and which would minimise costs. The LUI, in conjunction with the manufacturer, "Sintacel" Ltd., developed a relatively low cost system of adaptable services and furniture for education and science using standardised factory fabricated components. The basis of the system is the use of non-fixed furniture with regularly spaced overhead service booms and with drainage points on a regularly spaced grid in the floor. The standardised components with their flexible service and drainage connections can be rapidly re-arranged into a wide variety of layouts without the need of skilled labour."[2]

The range of service fittings and furniture which was developed is designed to meet the widest possible combination of requirements: lectures, practical class work, private and group study, tutorials and seminars. In addition, the range includes components developed from earlier DES work for commercial and social amenity areas. The range includes:-

a) A basic services distribution for electricity, water and gases using a system of overhead booms, drainage being provided by a permanent grid of floor points.

b) Moveable supplementary services components - gas and electricity bollards, taps and sinks and drainage channels.

c) Moveable storage, display and seating provision dimensioned to conform with the appropriate BS for science and educational furniture.

d) Mobile fume cupboard.

e) Moveable, knock-down rooms and stores which plug into the booms for services and make use of the existing floor surfaces, modified if necessary by carpet tiles.

1. see Architects Journal. 16th August, 1972, or A J Branton and F P F J Brake, Laboratories Investigation Unit Paper No.6. Adaptable Furniture and Services for Education and Science. August, 1972.

2. F Dewhurst and A M Rodgers. Adaptable Laboratory Design. Laboratory Equipment Digest. February, 1975.

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THE PLACE OF RESEARCH

"A commonly drawn distinction between the universities and the polytechnics, is that polytechnics give highest priority to teaching and that the courses which they offer are greater in breadth than those of the universities whereas the universities are primarily research oriented. When the matter is fully investigated, however, it is is abundantly clear that there is no absolute distinction between the two, they are both involved in the 'pursuit of truth' and 'the advancement of knowledge'. They both give their students the opportunity to develop their deductive, speculative and creative originality. The differences between them lie in their approach and priorities. Both sectors are mosaics of excellence, indifference and low quality. Neither sector has the monopoly of any category.

In this paper I shall compare the two in terms of the emphasis which they give to research and evaluate the problems facing the development of research in polytechnics.

The DES, in a policy statement on the polytechnics when they were originally designated in 1969 saw their main responsibilities as being teaching institutions but with the important qualification that:

> "..... it will be necessary to make the provision for research which is essential to the proper fulfilment of their teaching functions and to the maintenance and development of close links with industry, particularly local industry, so as to promote the rapid application of the results of research to its problems".

It could perhaps be read into this that polytechnic research should be more 'applied' than that of the universities, but certainly it does recognise that teaching and research in HE do go together. It is unrealistic and artificial to segregate research from teaching. If the complete aims of HE are to be achieved by the polytechnics, then research becomes a necessary part of their function at both the undergraduate and postgraduate levels - the latter being merely a natural extension of the undergraduate work.

A recent CNAA working party report on polytechnic research expects "a significant proportion of staff involved in the teaching of courses leading to its awards to be engaged in research."

The same report also states that

"an institution teaching to degree level, whether a university or a polytechnic, must sustain an adequate level of research activity, as part of its teaching function. Universities and polytechnics cannot therefore be distinguished on any ground of principle in their concern for research, although there may well be differences in content and balance."

The inescapable fact is, however, that to date the polytechnics do not have a good record for research achievement, certainly in terms of the standards operated by universities and research organisations, namely publication in learned journals. To be fair to the polytechnics, one must question whether such publications are a true index of 'success' A great proportion of polytechnic research is carried out for industry and by its very nature is confidential and/or not suitable for conventional publication. However, an examination of the number of patent applications made through the NRDC shows that the university record is superior to that of the polytechnics. Fortunately, there are examples of polytechnic research of the highest calibre and comparable to any within the universities. For example, in the biological sciences, the work being carried out by the biophysics group at Portsmouth Polytechnic on nuclear magnetic resonance studies of macromolecules particularly histones, has gained an international recognition, and the facilities provided there mainly by the SRC are second to none.

Before attempting to account for the generally poor state of polytechnic research, I think it is worth asking the question 'why does anyone carry out research?' It is perfectly true that research encourages the kind of lively mind best suited to teaching at undergraduate and postgraduate levels, but I doubt whether this is the motive for doing it. Moreover, I would even agree with those lecturers who say that it is not necessary to carry out research personally in order to be a successful teacher at this level. There is certainly a need for them to be able to interpret and assess the research carried out by others. Stronger motivations for carrying out research must be the inherent curiosity to find a solution to previously unanswered questions and to feel the unique satisfaction of having resolved a particular, perhaps obscure, problem. Coupled with this is the motivation of professional advancement and even personal fame and honour. Research involvement gives additional spin-offs - better undergraduate and M.Sc. projects, self development (e.g. a higher degree) and the challenge and experience of supervising postgraduate students.

Universities have always acknowledged and rewarded national and international reputations which successful research brings in its wake. The unfortunate consequence of this has been the overwhelming weight given to research publications in promotion considerations. In contrast, the polytechnics to date have undervalued the research efforts of their staff. Promotion has all too frequently gone to the good administrator (or, more truthfully perhaps, the willing administrator!). Junior staff are left with the impression that administration is the surest way to career development and hence tend not to grasp the available opportunities for research. In many ways, this lack of recognition of the contribution of research to HE was inevitable. Polytechnics evolved from technical colleges and colleges of technology whose staff had

unrealistic teaching loads and lacked research facilities. Moreover, the recent rapid growth experienced by polytechnics was bound to give rise to a situation where the greatest reward went to the administrators and course developers. I would not wish to suggest that this was the wrong order of priorities but it has to be acknowledged that it has had repercussions as far as research is concerned. I feel that the time has now arrived when the balance should and must be redressed. With many departments reaching a period of consolidation and giving increasing attention to postgraduate education, a greater channelling of resources - staff time, technical assistance, research personnel, equipment etc. - to research is essential. The CNAA working party report on research resources in Polytechnics is in accord with this view.

What type of research activity should polytechnics be engaged in? The simplest answer would be 'any that is worth doing and for which there are the necessary resources and staff of the right calibre'. The CNAA, in its report of resources for research in the polytechnics, took a very broad view of what constituted suitable areas of research and itemised eight categories:

(a) fundamental research,
(b) applied research,
(c) consultancy,
(d) private professional practice,
(e) curricular development and educational research,
(f) scholarship in the humanities,
(g) creative work in the arts, and
(h) private study.

This definition is so generous that no true academic in HE could possibly fail to engage in some suitable activity. The main problem, however, is one of categories and available resources. The Polytechnic Research Committee at Hatfield Polytechnic recently gave considerable thought to this question and identified three categories:

(a) Action Oriented Research - research designed to have a specific application in a field of activity where it will lead to some specific benefit or output e.g. the conservation of natural resources, the improvement of standard of life and health, the solution of problems in modern society of human, scientific and technological problems.

(b) Mission Oriented Research - research undertaken without any specific application at the time but where future developments may lead to beneficial results, e.g. in fields of medical and biological research.

(c) Curiosity Oriented Research - research undertaken without any specific application in mind and where there is no specific field known for possible future application.

Since the majority of courses in the biological sciences offered at polytechnics carry the term 'Applied' and many are of the sandwich type, it does not seem

unreasonable that on the research side, emphasis should be given to action and mission orientation projects on the above classification. This is in line with the CNAA requirement for research degree registration that an industrial supervisor be associated with the project.

Resources

The major resources to be considered are academic, technical and student/fellow manpower; capital equipment and revenue. The severe lack of all three will superimpose the question of relative priorities.

(a) Manpower

Without in any way questioning the academic integrity and ability of any HE staff, I think it is fair to say that they are not all equally qualified and able to undertake research either on their own, or, more particularly, to direct postgraduate students for a higher degree. The proportion of staff in the sciences with a research qualification is higher than in other disciplines which in part accounts for the greater state of development of research in the sciences than in other areas. The tradition of research in the sciences is also a factor. In the arts, humanities and even engineering research experience has not in the past been considered so necessary. In engineering, professional recognition has been regarded as far more important. With increasing pressure being placed on polytechnic staff from DES, CNAA, NRDC and Directors and Governors, staff in those areas of a college which lack a tradition of research do face real problems in getting worthwhile research established. In particular they lack experience of supervising post-graduate students and an appreciation of what is really expected of them. The Polytechnic Research Degrees Committee at Hatfield has recently been giving some thought to this problem and has set up a small working group to explore the possibilities of giving new staff some form of guidance in facing these problems.

If some form of priority is given to certain areas of research it does not follow that other staff should desist from the pursuit of knowledge, but rather that not all those who do pursue it should feel obliged to carry it out with a view to it leading to original publications. Such people must continue to assimilate the current literature in their field and to put it in its proper perspective and develop it into the undergraduate and postgraduate curricula. These individuals could also give outlet to their research abilities through consultancy where the problem is more one of application of existing knowledge to new problems. This can be as academically demanding and personally satisfying as 'pure' research.

In any department in HE there are many other essential tasks other than teaching. Course tutoring, timetabling and room organisation, student recruitment and general administration are all important in the smooth running and success of the department. Since no individual can devote more than 100% of his effort to departmental activities it has to be accepted

that all such activities, including research, must be equal when it comes to the question of promotion and career development.

An aspect of promotion, which is particularly relevant to research is the appointment of Readers. To date, the terms under which the DES approves such appointments have been restrictive. A very high research standard is expected and the terms of the Burnham Report require the Reader to be a promoter and manager of externally funded research in a department in which a substantial volume of externally funded research is already established. This excludes the appointment of a person specifically charged with the task of developing and co-ordinating research. I believe that most people concerned with polytechnic research would like to see a more liberal attitude taken to the appointment of Readers.

One of the most important research resources is research assistants and students financed by LEAs and research councils respectively. Generally they are too few in number. In October 1971, 27 polytechnics shared 829 assistants, but some had as few as 4 and others as many as 80. Some LEAs have severely cut the numbers of such appointments, while in others the numbers have failed to keep pace with the increase in staff numbers.

Research Fellows financed by the LEAs are much fewer in number. If polytechnics seriously wish to encourage and develop research I feel strongly that all major areas of research should have associated with them a fellowship and a minimum of two or three assistants. This impinges on the concept of group research, which I shall refer to late. It is of paramount importance that polytechnics resist the urge to reduce the number of their research personnel appointments as an expedient economy measure.

Figures published by the research councils clearly show that the public sector of HE has received a minimal number of studentships in comparison with the universities.

SRC Studentships 1973

Quota Awards

	awards sought	no. allocated and as percentage of number sought
Polytechnics	246	50 (21%)
Universities	4042	2034 (50%)
Total	4288	2084 (49%)

The SRC recently announced that for 1975/76 there would be a 9% cut in the number of their studentships but that the number of CASE awards would be increased.

SRC Studentships current at 31st December 1972

Total 5959

Polytechnics 104 (1.7%)

Polytechnics:-

Biology	23
Chemistry	25
Enzymology	1

NERC Studentships in post 1973/74

		specifically appointed in 73/74
Polytechnics	6	1
Universities	692	253

NERC Fellowships

Polytechnics 0

Universities 17

My experience of making applications to SRC, NERC, MRC, etc. is that the merits of the project appear to be almost irrelevant and that irrespective of the number of awards sought, an allocation is made of one, or more commonly, none. In a real sense the polytechnics are in a cleft stick. Their annual research publications are generally few in number and hence the research council's decisions go against them which in turn loses them the opportunity to do more research and get more publications.

There is evidence that the SRC, at least, is beginning to recognise the problem and the setting up by them of a Polytechnic working group is a welcome development.

Once the allocation of an award has been made, it can be a problem to fill the post. Difficulties may arise from the value of the award and the general lack of recognition of polytechnics as centres for research. But above all, I felt that we are hoist by our own petard in that our students are actively sought by the universities and research organisations because of their industrial experience and greater motivation whilst at the same time there is no evidence that universities encourage their students to go on to polytechnics. There is clearly a conflict of interests here. On the one hand we encourage our students to continue their studies in other institutions to gain a wider experience and yet at the same time such a philosophy is detrimental to our own research effort. Perhaps we are too philanthropic!

Active research requires adequate technical support. The CNAA recently estimated that the staff:technician ratio was rarely better than 2:1 in polytechnics but it is fair to say that as a result of CNAA pressure it is beginning to approach 1:1 in the biological sciences. The problem, however, is not

only one of numbers but of quality. The higher salaries paid by industry and the universities make it difficult to retain highly trained technical staff. Here again, polytechnics should press LEAs to realistically evaluate the responsibilities and value of technical staff.

(b) Equipment

Polytechnics seem to vary in their resources in terms of equipment for research. The problem is not helped by having to justify capital items costing over £1,000 solely on the basis of teaching needs. However, some colleges do seem to have made out a successful case on the grounds of research.

Capital grants from the Research Councils to polytechnics are even rarer than studentships:

SRC Grants to Life Sciences 1973/74

	All Institutions	Polytechnics Share
Biology	£5,622,000	£153,000
Chemistry	£5,355,000	£70,000
Enzymology	£1,680,000	£8,000
Total	£12,657,000	£231,000 (1.8%)

According to the CNAA working party, polytechnics differ considerably in the proportion of their total budget spent on research. Figures range from 0.7% - 15% with the majority in the 5 - 6% region.

A point which many polytechnic staff find irritating is the lack of revenue to attend national and international symposia. All too frequently the sum allocated to departments for courses and conferences is frustratingly low, (e.g. £10 per annum per head at Hatfield). A particularly disturbing feature of this is that it also affects research assistants registered for higher degrees.

One type of research activity which overcomes the majority of these financial and manpower restrictions is sponsored research - as opposed to consultancy. Providing a department has some special facilities or expertise, this can be a financially and academically attractive form of research. It can even be used to subsidise other research and teaching in the department. It presents its own unique problems such as lack of publishable results and meeting deadlines irrespective of other departmental pressures.

It is evident that resources for research in the polytechnics are severely restricted and that the assignment of some order of priority is inevitable. Hatfield has given considerable thought to this and as a matter of principle has decided that action and mission-oriented research should receive equally

high priority, with curiosity oriented research being of lower priority. Action research is most likely to attract outside funds, but may initially require internal support to get it off the ground. Clearly any assignment of priority will be controversial and generally we do not rigidly apply these guidelines. Such factors as the discipline involved and whether or not its research activities are well developed are taken into account before a final decision is taken.

One final point about resources. If it is sincerely accepted that research is a legitimate activity for the public sector of HE, then why should it have to be carried out on a shoe-string budget? Why should not generally acceptable standards be agreed for such things as laboratory space, revenue costs, conference expenses and sabbatical leave, and then be published as widely known norms which should be applied in all institutions?

Organisation

As I have already implied, I believe that, given the prevailing conditions for research in the polytechnics, individual, isolated research is inefficient and doomed to make slow progress. Moreover, it leads to the isolation of any postgraduate students involved. At Hatfield, in the biological sciences, we have attempted to overcome this problem by setting up research groups - specifically Biochemical Physiology; Biocides; Ecosystems; Fermentation Technology and Plant Physiology. They were deliberately made multi-disciplinary, i.e. they did not coincide with the teaching groups, in order to encourage cross fertilisation of ideas. Each of the five groups is charged with the task of rationalising and fostering research in their area and with the development of the educational needs of their postgraduate students. Each group is autonomous and has evolved its own character in terms of types of meetings and their frequency etc. A research committee has responsibility for overall co-ordination and allocation of such resources as assistantships. Since teaching and research are so intimately interrelated, the teaching groups are responsible for day to day financial support. The system has worked well to date.

The relationship between research students and their day to day supervisors is of course a very personal one. We deliberately encourage two members of staff to be intimately involved with each student and in addition, each student also has an industrial supervisor. Irrespective of the number of hours he is officially allocated for supervision, in practice the supervisor must undertake to meet all the demands made on him. The extent of this varies enormously from student to student and the stage which the project has reached. The time which is actually taken up in research supervision is urgently in need of reassessment, particularly in the context of the calculation of student staff ratios and Delaney norms. There are, of course, certain fundamental questions to be considered in relation to supervision, e.g. what is the nature of proper supervision? What are the necessary attributes to be an acceptable supervisor (e.g. for CNAA approval)? How much of a supervisor's time can a student rightly demand? What amount of postgraduate studies is it reasonable to

expect them to pursue? There is also the question of how best to organise an academic's timetable so that he can undertake some serious research. Research, especially in the life sciences, cannot be conducted on a three hours per week basis. Timetables must be arranged so that staff have several free weeks in a block.

A further way for staff to be continuously involved in research is to develop contacts with local industry, research institutes, hospitals and so on. For example, some of my own research is carried out at St. Albans City Hospital in conjunction with the Principal Biochemist, Dr. Burnett. My LEA assistant is based there, as is a full time student financed by the NHS. We also have two part time students who work one one day per week and during vacations. I arrange my own timetable so that I spend a day each week there. The result is beneficial to everyone, and I am sure that more of this type of co-operation is possible and that it could become a distinguishing feature of polytechnic research.

Finally, there is the question of registration of students for a CNAA research degree. A number of polytechnics have been given authority to register M.Phil candidates on behalf of the CNAA. This trend is certainly welcome and hopefully one day will be extended to Ph.D. registrations. Of course it raises the question of what degree of autonomy is desirable from CNAA and what, if any, are the inherent problems. Independence from CNAA and its specialist subject boards places considerable responsibilities on the polytechnics. The Polytechnic Research Degrees Committee, whose members are drawn from all disciplines, must inevitably rely heavily on the recommendations of the supporting Departmental Research Committee. My experience at Hatfield, however, is that the system works well, in fact in some cases the standard which is set seems to be higher than the CNAA board would have applied. Moreover, we have found that the Research Groups play an invaluable role in degree registrations, since it is at this level that the real expertise lies and where real academic judgements can be made.

I have tried to cover what seem to me to be the most important problems facing research in the public sector of HE today. Research in these institutions has reached the point where its role, resources and organisation all need to be carefully evaluated. The recent Houghton Report has important implications for post graduate work. Research must become an integral part of polytechnic work and greater acknowledgement should be given to it. It would be most unfortunate for the polytechnics if, as a consequence of the current economic situation and the pressure to make economies in education, research was to receive yet a further set-back."

Discussion Arising

Dr. Wilson was asked whether he could make any predictions about the future of research in the polytechnics. He was not optimistic, in view of the fact that there were such strong pressures to make cuts in spending in every facet of polytechnic life, although he could make no guess at how long term these pressures would be. However, it was worth making applications to research councils for studentships. Perhaps one reason for the abysmal past record was that not enough applications had been made or simply that staff lacked experience if making such applications. It was important, however, that members of research council boards making judgements were aware of the situation in the polytechnics and did not expect a mass of published material to accompany each application.

Mr. Norris, HMI, added three comments. First, he reminded the conference that polytechnics were not intended to be the same kind of institution as universities and had a larger proportion of sub-graduate work and these areas did not depend on the same kind of research as was carried out in universities. Secondly, there was the question of rationalisation. Too many people were trying to do the same thing. There was probably 30%-40% surplus capacity in the higher education system and there was a further complication in the fact that we do not know whether or not this surplus capacity will be required over the next ten years. This meant that it was difficult to get resources re-allocated. Thirdly there was the attitude of the general public. Tax payers were altruistic but could only provide money up to a certain level. Dr. Wilson added that he had no objection to the DES scrutinising carefully the research that was carried out in polytechnics, but he did feel that the same standards of judgement should be used as were used for considering university research projects, and he was not convinced that this was the case at present.

Dr F C Webber,
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Wolverhampton

Degree and Institute of Biology Qualifications

"I have been asked to examine briefly the specific area of Degree and Institute of Biology qualifications and hopefully to add a few more possibilities to those surveyed by Dr. Green in his introduction to Project A which might be developed in syndicate groups.

growth of FE biology

In the 1950s FE biology was relatively uncomplicated. The curriculum consisted of GCE 'O' and 'A' level in biology, botany and zoology and some of the more fortunate colleges offered botany and zoology at B.Sc. London (External) level. Biology sections were usually small with two or three biologists carrying the whole teaching load. At the end of each year the students were directed to the Examination Centres and the staff sat back and waited for the results before starting all over again the following session.

Then developments began. The introduction of biology at ONC and OND level was followed by the establishment of HNC and HND courses in Applied Biology. These courses allowed colleges to develop a range of special options appropriate to the needs of local employers. These HNCs and HNDs were quickly followed by the initiation of professional degree-equivalent courses sponsored by the Institute of Biology which again allowed colleges the scope to submit a range of specialisms appropriate to local and national needs.

The establishment of CNAA provided yet another boost for colleges to propose and develop courses up to honours degree level over a wide range of specialisms. No doubt the element of competition was not an insignificant factor in stimulating this ever-increasing diversity in the nature, structure and flavour of biology courses at this level.

More recently the popularity of Combined Studies or Joint Honours courses in science, including biology options, and more recently still the advent of modular courses, has further complicated the pattern of provision.

Thus, in about 15 years biological education in FE has undergone tremendous changes as a result of opportunity and demand. The rapid development has involved a high degree of diversification and this is apparent from the plethora of course titles. That such a diversity of courses has been established is itself

a reflection on the enthusiasm and imagination of biologists in the colleges but at the same time it is this diversity which is the root cause of many of the problems which we now face.

justification of diversity

Diversity in the provision of courses nationally may be defended on the grounds that biology is now such an enormous subject that no single standard degree course could adequately embrace all its aspects and therefore the content of any particular degree scheme must be selective if it is to be of sufficient depth to be intellectually demanding. Therefore in order to meet the different needs of students and employers it may be argued that diversity is a necessary feature of biological education in advanced FE.

Diversity of courses, and course content, may also be defended on the grounds that it offers a wide choice of biological education which will cater more precisely for the specific requirements of individual students. But to offer a wide selection of options in a single course (particularly the more traditionally structured single subject course) has the effect of spreading students thinly through the available options which in turn is very demanding in terms of staff teaching hours. In fact it is not very long ago that the administrative procedures for gaining additional staff appointments actually encouraged a course structure which was splintered into numerous options. The Pooling Committee Recommendations of Student Staff Ratios have completely reversed that approach - and perhaps rightly so. Certainly the principles behind these recommendations is sound - it only remains for the Pooling Committee to get its figures right before their recommendations are fully implemented. Nevertheless, whatever the final SSR figure may be, these recommendations provide a means of exerting strong pressures on departments to look closely at their courses in order to find ways of modifying or restructuring them and examining them in terms of SSRs, in order to make them more efficient in SSR terms, if necessary. Departments may have to do this if only to protect staff from excessive teaching loads.

diversity with efficiency

If diversity is justified, if it is considered to be a desirable feature of biological education in advanced FE, the main problem to be tackled is that of maintaining diversity with efficiency.

If we consider M.I. Biol. courses, we are dealing with a system which includes a range of about a dozen specialist subjects being offered in 54 courses and 25 colleges spread across the country. Each course has a large element, 'Principles of Biology', which is common to all the courses. The recent restructuring of M.I. Biol. has increased the proportion of common, core, material quite significantly and so any college running two or more M.I. Biol. courses gains an immediate advantage in terms of SSR efficiency by combined teaching of the core material to all their M.I. Biol. students.

One essential feature necessary for the award of M.I. Biol. is that candidates should have reached a standard which is normally accepted as being equivalent to that of a second class honours degree. If this is the case and if M.I. Biol. courses are offered in Departments which also run biology degree courses, why

could they not attempt to arrange a proportion of common teaching, particularly at the M.I. Biol. Part II level. In many cases this is not now done, because of the difference in course structures between the courses. However, I believe that much could be done to revise course structures so that they become more compatible while at the same time meeting the requirements of the validating bodies concerned.

For example, at The Polytechnic Wolverhampton the biological Science degree course was recently revised and resubmitted for approval to CNAA. The first year (Part I) course is a common basic year for all students, but years two and three (Part II) have been restructured on a modular basis. During Part II, 30 modules are offered, each being self-contained. The set of 30 modules are arranged in two groups of 15 modules, one group being offered in Semesters one and three, and the other group being offered in Semesters two and four. Each module lasts 15 weeks. In each Semester the 15 modules are grouped in threes and each trio is offered on one particular day of the week. Thus during the two year duration of Part II an individual student could, if he wishes, read any two of the modules in a group. This arrangement enables second and third year students to be taught together which represents a considerable saving in teaching contact hours. At the same time, the viability of a wide range of modules is more assured because at any one time two intakes of students are selecting from modules on offer.

A structure of this type provides a wide choice of modules from which students may select those which meet their particular interests or career needs. But in relation to the M.I. Biol., at the same time it allows the department to put together a particular combination of modules which would provide the appropriate material for a specialist subject of an M.I. Biol. course. Currently, for example, The Polytechnic Wolverhampton has submitted an FE 21 to extend the range of M.I. Biol courses at the Polytechnic to include an option in Applied Ecology. If approved, Part I of this course would run largely in conjunction with the existing M.I. Biol. courses but Part II work would largely be taught in common with the Part II of the degree course. Thus any one module could be populated by second year degree, third year degree and Part II M.I. Biol. students. If successful it is possible that the scheme could be extended to incorporate the existing M.I. Biol. courses in Plant Pathology and Entomology. Further obvious extensions would be to consider Microbiology and Animal Physiology as additional courses.

Thus, in terms of Project A, the suggestion being made is that rationalisation and greater efficiency in the use of resources might be possible by careful restructuring of courses so that arrangements for courses at a similar level become more compatible and consequently allow the use of common units or modules in two or more courses.

transfer opportunities

Perhaps another area which could be opened up for further discussion, with a view to rationalisation in the provision of courses is that of transfer opportunities. Normally this is understood to mean the availability of transfer opportunities for students between courses. This is certainly important. I believe firmly

that students taken into the FE/HE system would be allowed the chance to emerge from the system with the highest level and most appropriate type of qualification of which they are capable. In some departments in which a range of courses is available this already goes on to some extent. Transfers take place in both directions between HND and degree courses and between biology degree and combined degree courses. For the most part these transfers take place within a department. I feel sure that not only is there room for more co-operation between colleges, but there is a definite need for it in order to provide the best route through the system for the student. There may be reluctance to encourage our students to transfer elsewhere, as a result of SSR considerations, but this could be a 'swings and roundabouts' situation.

More significantly, in terms of effective use of resources, the principle of transferability could be applied to staff. If we could establish greater co-operation between colleges during course development, would it be possible to reach acceptable agreements for staff exchanges? By this means departments could maintain or increase the diversity of range of modules/options/topics without the necessity of having to create new appointments for highly specialised staff who often might only teach their specialism for half or a third of their teaching time. If such co-operation could be established, one wonders what administrative obstacles would be encountered, but this seems one possible means of utilizing scarce staff resources more efficiently.

comparability of standards

Associated with the issue of diversity is the question of comparability of standards. The M.I. Biol. structure is such that all students sit a common examination at the end of Part I which ensures that students embarking on Part II have reached a certain minimum level of competence. But the comparability of standards in CNAA degree courses is more of a problem. Standards are set and assured by the appointment of external examiners who have specific functions and are associated with specific parts of the examination process. It seems, nevertheless, that standards vary between courses and colleges as they do between universities. I wonder whether it would be helpful to us, perhaps for our own protection, if some means could be found to give at least some indication of the variation in standards between our courses. Many of our degree courses will have elements in common, particularly perhaps in the first year, e.g. cell structure and function, genetics, basic biochemistry. As a tentative suggestion would it be worth at least some departments co-operating to produce a bank of multiple choice questions in the common areas from which a paper could be compiled each year and presented to all candidates in the co-operating group? Such a scheme would give some indication of comparability of standards between our courses and, even if embarassing, would at least give us a guide to our own standards in relation to others in the group."

S F Everiss, Vice-Principal, Paddington College

Medical Technician Qualifications

"People who go into hospital for the first time, often very ill indeed, are frequently surprised to find that once they are in bed and the trauma of the immediate emergency has passed, they are treated piecemeal rather than by the traditional whole-body approach to medicine. The different parts of the body have their own experts and these experts are often not doctors. For every 100 doctors there are 120 auxiliaries needed and the numbers of medical auxiliaries are increasing. The original seven professions supplementary to medicine have been increased by one, the orthoptists, although the Act setting up the professions visualised 12. There are other special skills which are not on the official list either because they have not yet been accepted by the Council for Professions Supplementary to Medicine or because they prefer not to be (e.g. speech therapists and medical social workers) or are not officially recognised.

demand for medical auxiliaries

All these medical auxiliaries have some contact with the hospital service but they also treat patients outside the service and the families of patients are important. Local authorities, research and teaching also require their services and because of their education and training they are valuable outside the medical field. The demand for these workers is greater than the supply. They are much sought after and this cry for more can swamp course organisers. There is pressure to produce and disregard standards. The running of such courses is a service to the community and therefore medical auxiliary courses may have to be given priority over other courses.

The courses attract both sexes but rather more women than men. There is consequently 'temporary retirement', 'wastage' or 'movement' of skilled personnel and this must be born in mind when diagnosing a sequence of courses in the career structure.

All these auxiliaries require the ability to work fast with precision, often in emotional circumstances of illness and so all must subscribe to an ethical code of conduct. All work with medical doctors in a climate of continuity of help and care originating from the family doctor - the NHS ideal.

training problems

The Health Service reorganisation involves rethinking a massive training programme which sets in-service objectives with evaluation at intervals. The college has to develop a relationship with the new training boards and whichever of the 90 area health authorities are relevant. It has to have a policy on in-service training schemes and decide whether or not to help write, oversee or evaluate them or leave this to the Health Service. If it does decide to participate it has to decide whether courses should prepare students for their immediate employment needs or for the future.

The continuing shortage of medical auxiliary staff and the consequent pressure from industry is reflected in the number of the centres in relation to numbers on course. For example ONC is offered at 57 centres. Of these, 40 have an intake of 10 or less students and there are only three with numbers

large enough to justify specialist lecturers and a choice of days for college attendance and only four offer block release to solve problems relating to travel and geographical location.

mode of study

Most courses are part time, but there has been some interest in full time courses partly due to the fact that with full time hours being nominal a college gets five times the hours from a full time student as from a part time student, with virtually the same effort. The development of a 'CAT syndrome', i.e. the dropping of 'low level' and 'part time' courses and conversion to full time work, where possible Al, is apparent. While there may be good educational reasons for such changes, it seems to me that the needs of the college are sometimes put before the needs of the students.

We should consider whether or not students should enter medical auxiliary courses directly from school and without any form of induction. The jobs they are training for can be horrifying for some individuals, being concerned with blood, faeces, urine, deformity and even death. Can the advantages of full time course work in such circumstances be said to outweigh the advantages of a part time mode of study with its ease of transfer to other careers and courses?

Employers need pairs of hands for routine work, plus knowledge, plus specialist experience. This is often difficult to reproduce in a college. With money short we must be aware of the cost return of the course, which can influence whether it is full time or part time.

There is an advantage in a reasonably early basic qualification such as ONC which can be used as a qualification for transfer to a new career or for later return for further training. It takes a long time to obtain a degree and, in this field, a degree can only be said to indicate potential. According to Dr. Tully and Professor Mellanby there is "great overproduction of graduates", especially those with Ph.Ds and a corresponding underproduction of scientists for skilled repetitive work. Because of this it is said in USA and Europe that "graduates must be made to take non-graduate work". There is then a tendency for industry to prefer graduate entry for these non-graduate jobs and later they demand graduate entry only. Thus the education industry is promoted despite industry's need for experience and the preference of young people for jobs which bring them money, plus satisfaction plus education.

non-biological content

Courses such as Physiological Measurement highlight other problems in the medical auxiliary field because their titles indicate an obvious need for numeracy and physical science. Biologists are said to be innumerate, but when they see the relevance of numbers they do become numerate, although they may be less abstract in thought than mathematicians, preferring flow charts and diagrams to formulae. Should the mathematics in FE for biologists be taught by mathematicians or by biologists aided by calculating machines? While we hear of the great shortage of mathematics teachers they seem to be reluctant to let anyone else encroach on their territory.

There is also a strong physics and medical physics lobby, but few students on these courses. We have seen the collapse of once great physics and chemistry empires because of an inability to adapt - an insistence upon long courses of pure physics or pure chemistry for people whose need is for biophysics, biochemistry or electronics. Will the biology empire collapse also, or will it save the others? Biologists are new on the FE scene, and I feel sometimes they are too broad-minded and too busy whilst our physics and chemistry colleagues have the time and are sufficiently predatory to strongly promote their subjects - there is nothing like impending death to focus the mind on personal predicament! Thus there can be strong competition from non-biological departments for students instead of co-operation.

modular structures

The Technician Education Council has set our basic courses apart from the life sciences. Modular structures are proposed. Do we need them or should we integrate our courses around biology? The specialists on the sector C1 general committee are likely to propose modules of pure maths, physics and chemistry in all biology courses. This would keep our physical science colleagues employed and help CGLI over its cash flow predicament because there would be fewer examinations, more candidates sitting each examination and more work foisted upon the colleges whilst CGLI retain control and reap the harvest.

The Medical Auxiliary courses are successful precisely because they are relevant to the job and not academic. TEC could change this. We already support a parasitic structure of Vice Principals, Vice Provosts, careers officers, counsellors, and resource officers to which we may well add mathematicians, physicians and chemists - all colleagues.

Retraining, redundancy, redeployment and return-after-break courses are important in this field because jobs are not filled. Job mobility is great because there is so much work for the students from our courses. We must avoid becoming inflexible by restricting the entry requirements due to restrictive course structures, too great a dispersal restricting choice of opportunity, too many full time courses when returning workers can only attend part time and too restrictive starting dates for courses when induction may need to precede course study.

To summarise, the main areas for consideration may be listed:

(1) The balance of standards in relation to demand and the effect of demand upon standards.

(2) Ethics and the code of conduct for medical auxiliaries.

(3) In-service courses and their evaluation.

(4) The specialist content of the courses - should it be done in or out of college; by full FE teachers or specialists teaching part-time?

(5) The balance between full time and part time courses.

(6) The extent of the currency of qualifications.

(7) The desirability of degrees - they give an indication of potential but no skill and experience in dealing with patients.

(8) The mathematics content.

(9) Competition from physics and chemistry departments for students.

(10) The desirability of modular structures.

(11) The importance of achieving flexibility to allow for in-service training and retraining."

L G North,
ead of Department
iological Sciences,
Ewell County
echnical College,
Surrey

Higher National Diplomas and Certificates

"The original Higher Endorsed Certificate in Biology was virtually created out of nothing due to the quick thinking of Mr. Norris when the external London degree was taken away from us. The approach that led to the HEC has not changed fundamentally. The original HEC was in three subjects: Applied Botany, Applied Zoology and Biochemistry. The Applied Botany was in fact largely micro-biology and soon the botanical aspects were dropped. The Applied Zoology was largely physiology and pharmacology and the small percentage of zoo geography and so on was also dropped. This Certificate was most suitable for our catchment area. The creation of the Ordinary Endorsed Certificate, a three year course, followed. Now the wheel has turned full circle and we are seeing the introduction of the Technician Certificate, which is also a three year course. The wheel has also turned full circle at the higher level. The HEC which later became the HNC began with three subjects, dropped down to two with the introduction of Quantitative Biology which became the core subject and students studied one other subject chosen from basic subjects such as physiology, pharmacology and entomology or more exotic ones such as biometrics, plant pathology and animal pathology. Every aspect of biological expertise has been delved into in the production of various HNC courses throughout the country. I suspect, however, that with the introduction of TEC there will be something of a return to the integrated course. The medical biologists have always worked in this way. I personally believe that an integrated course will give a foundation to a technician, allowing him to move around the country, trying different jobs and improving his expertise which will be more useful than the highly specialised HNCs. I am not decrying these - they met an important need - but industry has recently changed its attitudes to the HNC. Almost as soon as they get their HNC people are being promoted away from the subject they studied. Therefore it is logical to introduce a more generalised, integrated type of course. TEC will be a golden opportunity for this. Thus, just as the old HEC was a course in which we hoped to cover the whole field of applied biology in three integrated subjects, perhaps we can attempt the same thing through TEC.

The HND was introduced some time after the HNC. We originally hoped that like the HND in the Physical Sciences it would lead to Licentiateship of the Institute. Unfortunately this did not materialise and the consequence was that the course got off to something of a false start. But it has now settled down and serves a valuable purpose. I hope the TEC Diploma will do the same.

I have always regarded the HND as a course for failed degree entrants. I know this concept meets opposition but it is the case that many HND students have made unsuccessful attempts to go to university and most have failed in 'A' level chemistry. Therefore they begin their courses with a sense of failure and the first thing that has to be done is to build up two things: their sense of imminent or eventual success and their ability in chemistry.

In a sense, the HND course is the type of course for which the college of technology is renowned - a course which gives students a second chance. In the future the college of technology will extend its retraining and in-service training functions - but this is a topic for another conference.

One of the main concerns of this conference, and of Project A in particular, is the problem of cutting wastage if a department is offering HNC and HND courses. One of the best ways is to put together part time and full time students. They do not necessarily mix easily, but this difficulty can probably be overcome with time. HNC students have so much to give in terms of work experience to the HND student. Equally, the HND student will have his sights set a little more realistically than at present. Many, being failed university entrants, still tend to want to go on to university and use the HND as a step to university entry. But the requirement is at technician, not graduate level. We have to teach these young people to accept a job which will provide the country with what it needs as well as giving financial satisfaction and suggest that they might possibly look for intellectual fulfilment outside their work, as do many arts graduates who end up in industry.

The function of both the HNC and HND is therefore the same: to produce good technicians. Although the HND course is a wider one, the level and type of employment of students leaving both courses is virtually identical. Therefore I see no objection to regarding the HND as an HNC in greater breadth, just as TEC intends to treat it. Out of this, I think, comes the only reason I can see for combining Certificate and Diploma students. Diploma students would attend the Certificate course and in addition study other aspects of applied biology, especially the technical aspect.

Thus the problem of avoiding wastage is really one of timetabling. Quite simply if each course takes two years, at least one fifth of them can be common, or two fifths if two HNC courses are running. Practical difficulties may be created: the logistics of getting all the students together; the possible detrimental effect on HND students of studying one subject in a block on one day and having the rest of the curriculum spread over the other four. Modular structures may provide an answer.

A final comment. Although the HND in applied biology failed to be accepted as suitable for leading to the L.I. Biol., there is no reason why chemistry students should not take an HND applied biology unit, eg. biochemistry, microbiology or pharmacology for their L.R.I.C."

Dr. T Green,
Head of Department of Science,
Bristol Polytechnic.

PROJECT A: A REVIEW OF THE CURRENT SITUATION

Conference members were asked to review the current range of courses and qualifications in the advanced bio-medical sector and consider whether present arrangements lead to the most desirable features in respect of economy of resources and of the interchange between courses which might be obtained. Syndicates were asked to include in their study a review of the provisions for examinations and qualifications and to consider the possibilities for rationalisation.

Introduction to Project A

"I do not intend to ape Mr. Norris's superb philosophic discourse in which he sets the scene for consideration of Project A. Rather, I shall concentrate on the nuts and bolts issues of the current situation.

The project is an all-embracing exercise, the boundaries of which are the constraints under which we all work: course approval procedures, enrolment numbers, numbers in options, staff and accommodation resources and materials and equipment costs, the last becoming increasingly important in our inflationary climate. I wonder in fact how we would fare if we had to pay a realistic cost for the facilities and materials we use in hospital laboratories? Certainly, as far as blood group serology is concerned, the South West Regional Blood Transfusion Centre is subsidising Brunel Technical College and Bristol Polytechnic by many thousands of pounds per year.

diversity

Biological science courses are the most diverse of all science based courses. They are interdisciplinary courses, integrating the life sciences and the physical sciences in various combinations and often incorporating social sciences, technology and engineering. This diversity makes it difficult to define what is meant by a biologist or medical technologist. The applied biomedical sciences have in fact spawned a number of new disciplines and industries, one of the most recent being concerned with the measurement of biological parameters. e.g. the manufacture of the EMI cranium X-ray scanner, a British invention which is apparently without competitors in this field.

The biological sciences abound with '-ologies' and '-imetries'. The titles of the various disciplines of the members of this conference do in fact reflect the diversity of science taught under the heading 'biological sciences'. Amongst the paramedical subjects, almost every occupation seems to have its own qualifying body and particular course. Even amongst courses which have drawn together a number of biological disciplines, there are many options, the numbers of students taking each vary from year to year, often in an unpredictable manner (sometimes influenced by the staff in post at the time). The influence of TEC could make the situation worse, if it is interpreted literally, due to the proposal to include industrial units with employers taking a leading role.

The attraction of the bio-medical courses for the students is in fact their diversity. Medical technology students, for example, view their special subject as the most attractive part of their course. It is my experience that these courses fire students with an enthusiasm not present among those students following the more homogeneous HNC course in chemistry which has no options and consequently tends to revolve around basic principles.

Therefore we have to resolve this paradox: the attraction to the students of diversity combined with the disadvantages of fragmentation and greater running expenses. Syndicates might examine the factors which lead to diversity and within this general heading include such points as vocational interest, institutional influences (i.e. professional influences) and traditional practices.

overlap

The overlap between the various biology based courses might then be analysed. Perhaps the courses that most obviously lend themselves to combination are the HNCs in Applied Biology and Medical Laboratory subjects. It is well known that the Foundations of Quantitative Biology and Medical Laboratory Science have many common elements and it would be beneficial to examine these in looking for criteria for identification of common study units. I know a number of colleges run these courses together and some run them cyclically, giving a combination of four different groups (i.e. first and second years in each of two courses), although I would imagine that difficulties must arise for the students if they are combined all the time. However, I am a strong believer in necessity being the mother of invention. If the students cannot get block release, and the college is located at a long distance from any other similar institution, it may be that it is not possible to run the course any other way than on this basis. If the students are happy, the results good and the DES and LEA approve, no other justification is necessary. Advanced technicians courses also lend themselves well to cyclic treatment on a part time basis.

Other more specialist courses such as those for some of the paramedical qualifications are often conducted on a block release basis, e.g. Physiological Measurement and Radiation Technology options in Scheme B of the HNC MLS course. Other courses such as Chiropody need to be conducted on a full time or sandwich basis. Thus there is a complex attendance pattern for biomedical

courses comprising full time, sandwich, block release and part time modes of study. But this complexity makes them more versatile and more easy to rationalise on a matrix basis. In this type of scheme common elements of varying lengths for various courses are used where the students combine. These compensate for periods when they study the specialist elements separately. Clearly, the matrix devised depends on the situation in each particular college and may well vary from year to year and even from term to term. The matrix also allows the use of the student staff ratio system to advantage, i.e. if students are in large groups for some of their time it is permissible to have the luxury of small groups for other periods.

As an example, a full time degree course could assimilate small numbers of part time degree students by programming the common units on one particular day in the week. Perhaps small numbers of M.I. Biol. students could also be assimilated in the same way.

approval

The main difficulty with these joint schemes is in the context of course approvals. Normally separate approval is necessary for each group of students, so that six part time students would be deemed not to constitute a viable course and approval for them would be withdrawn even though they were assimilated into the full time matrix thus requiring little or no additional staff. Nevertheless, RSIs may well allow colleges to run such a system if the case for it is well presented to them. Certainly in the South West we have been able to obtain approval for such grouped courses. Some of our schemes have been based on the use of a viable group of part time students to assimilate a smaller group of full time or sandwich students.

Perhaps I might give examples of how such schemes can operate, from the fields of chemistry and physics to avoid duplication with syndicate work, although the system is equally applicable to biology. The physics course contains student groups from three part time courses: A. Inst.P. (one year part time day and evening), Grad.Inst. P. Part 2 (years one and two, part time day and evening, run on a cyclic basis), and one full time course, Grad. Inst. P. Part 2 (one year). None of these groups are viable on their own but together they give an average class size of 14-15 students and reduce the staff hours from 44 to 24, a considerable saving.

The Chemistry scheme is more complex, with about eight different groups involved including part time, part time cyclic, sandwich and full time students. The average class size ranges from 13 to 18 students.

The M.I. Biol. course at Bristol under the new regulations is devised on similar lines to achieve greater economies in the use of resources. It was in fact devised in conjunction with Llandaff College of Technology, Cardiff, so that there would be an opportunity for transferability and inter-changeability of students, should this prove necessary. The first year is common to all students. They take 210 hours of Principles of Biology, the syllabus being laid down by the Institute. Their other subject is macromolecular biology which

takes 70 hours. In years two and three, which are run cyclically, there is some common ground - all students spend 40 hours on metabolic biochemistry, 45 hours on a project and 55 hours on instrumentation. In addition they spend 170 hours on the options; biochemistry, microbiology or mammalia physiology and pharmacology. Taking the scheme as a whole there is 58% common ground for students, which makes reasonable economies in the use of staff.

Apart from the obvious advantages of economy in the use of accommodation and staff resources, there are other benefits which accrue from matrix systems. They meet the criteria of flexibility and buffering against variations in enrolment from year to year and there is a sense of stability based on the fact that there is not an annual crisis every September in wondering whether each individual course can run that year. The examination results seem to be better, if anything, than when the courses were run separately, and I feel that the reason for this might be that larger class sizes give the students more confidence. One possible danger, however, is that if one group of students falls out, the whole integrated course may collapse, although this is not a problem which has occurred so far in the four years of operation at Bristol Polytechnic.

I am not suggesting, of course, that these matrix systems should be adopted in every case. If a course has plenty of students there is no reason why it should not continue to run on its own, although it might be advantageous to make provision for operating it in a matrix system should the need arise. Biology-based courses are still increasing in number, but this may not continue and in the present economic situation more flexible schemes may become necessary.

TEC

The proposed TEC unit system is, in my view, nothing new - it is simply a formalisation of the type of course I have described. Science departments have been running courses in this way for many years, sometimes as a strategy for survival. My fear is that with TEC, such systems may become over-formalised, over-organised, over-complicated and too rigid. It is not wise to legislate for all colleges to do exactly the same thing, so much depends on their individual pattern of courses. I would be appalled, if TEC intends to completely revamp all courses, as some TEC officials have indicated. Certainly in the biomedical sector such a revision would be unnecessary. Most existing courses are extremely satisfactory and all that is required is that they be adapted to fit in with a new administrative system.

common units with other disciplines

Turning now to other matters, biological sciences courses are inter-disciplinary which makes it possible to envisage common units with courses based on other disciplines. These include core subjects based on chemistry, physics and mathematics and subjects under the heading of general studies. Within a science department or faculty it is possible to envisage subjects such as analytical chemistry, instrumental chemistry and physics, statistics and computing, and environmental studies offered as common units in a range of different courses. At Bristol we have run LRIC Biochemistry, LRIC

Advanced Analytical Chemistry and M.I.Biol. Part I Biochemistry with some units in common, thus enabling a few Chemistry students to do a course in Biochemistry.

My experience of employment of HND Applied Biology students is that they often work as chemists. Therefore one should not disguise the fact that the chemistry input into the course is not just background information but likely to be relevant to their careers.

physical sciences and mathematics

This leads me to another point. Biology students at school are often put off chemistry because the GCE 'A' and 'O' level syllabuses are rather pure and formal. For the same reason, mathematics is a subject rarely studied by biologists at 'A' level. When these students proceed to applied biology and medical technology courses, which often have the requirement to study physical sciences and mathematics sometimes to a greater extent than their main subject in the first year, they can be put off, unless the course is well integrated. They then tend to drop the physical sciences in the second year, just at a time when they may begin to appreciate its usefulness. Therefore I tend to favour a thread of physical science running through the whole course, rather than being concentrated into the early stages. The student can then assimilate it more gradually, make greater use of it and go into a job having studied it more recently as an integral part of their course.

accommodation

Laboratory space is another limiting factor in many colleges. Specialised laboratories tend to be under-used, more general laboratories are often overflowing with students. There are two possible methods of overcoming this difficulty. A laboratory may be used by two classes at the same time, with two members of staff on duty. This is feasible in any fairly large laboratory. Alternatively, laboratories can be designed to be more flexible, with overhead services, moveable benches and moveable partitions.

modular courses

Economies in staff and accommodation may also be achieved by the introduction of modular courses. These may appear to cause complicated timetabling arrangements and difficulties of the student feeling bewildered by not belonging to a constant class group, but in practice these problems may not be very great. Another concept which aims at economies is the abolition of departments and introduction of discipline based schools, and the modularisation of courses lends itself to this type of structure."

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factors producing diversity

(1) Medically oriented and non-medical courses differ in their objectives.

Colleges frequently find academic non-relevant science easiest to provide because most lecturers still in post went through pre CAT universities and

obtained specialist qualifications in days when only biologists studied biology and even they studied it as botany or zoology. But employees look for direct relevance because they have to depend upon the expertise of students.

(2) Politics of short courses or long courses, full time or part time, subject or department balance, grading of departments and similar relationship of bodies such as C & G L I joint committees and CNAA. Professional institutes may not co-operate with each other. Colleges may see themselves as competing for students. TEC and SCOTEC may have different objectives. CNAA are not involved with them.

what courses have in common

Despite the diversity many biology courses involve:

some academic study usually related to the vocation of the student,

some vocational study in which science and professional knowledge are brought together,

some clinical or other specialist study upon which fitness to practise depends.

the core curriculum studies

The academic study and some vocational study can constitute a core curriculum which can be similar in joint committee applied biology and medical laboratory science courses and in CNAA Dip HE and life science degree courses. Members saw no difficulty with the joint committee courses but although the subject matter of the course is the same the entry qualifications differ from CNAA and students doing the same work together resent having differing end qualifications.

Integration is important and can be obtained by using the academic content as a vehicle for transmitting skills. Courses in which individual scientific disciplines are eliminated have proved successful - as in a foundation course science.

Modular courses can introduce considerable irrelevance and produce problems of student lack of interest.

If a core curriculum is made modular care is needed to adapt a thematic approach with emphasis on relevance in order not to intimidate the student. A thematic name to each module can be important.

specialist subjects within the course

If the course is for a vocational/clinical qualification specialist subjects within the course must be complementary. Professional bodies must co-operate to devise curriculum and appoint assessors.

The specialist subject is the vital aspect of the qualification to employers and may decide the professional acceptance of the course.

There is a greater student demand for specialist biology than for combined study courses.

ethical standards

Most biology courses have a direct (as in hospital) or indirect (as in medical research) relationship to service for patients. They therefore must have the support of professional bodies and registration boards and must maintain ethical and safety standards appropriate to such support.

costs

Many courses involve college (DES/LEA financed) and medicine (Treasury/NHS financed). Conversion to modules may involve transfer from NHS to college with consequent greater cost to ratepayers. The alternative is to group college and associated clinical centres and to strictly limit the number of such groupings.

course structure

Approach must be thematic with integration and if necessary staff must be re-oriented/retrained for this approach.

A plateau of entry is required at various levels for a sequential course if the qualification is terminal. A one-off module exemption is not necessary and if insisted upon would make it difficult for the student to identify with the course.

Members had a preference for on-going education.

The total course must be designed to enable the student to identify with it.

The physical sciences and engineering must be integrated into the total course. Rules 103 give guide lines which colleges have found valuable.

Modular courses are likely to increase the effort (and cost) involved because much counselling is needed to ensure the student professional acceptance, tutorials are needed to provide integration and emphasis appropriate to the objective, students are less likely to be concentrated in a few large centres (which can employ specialist staff) but will be in smaller groups each needing the same specialist staff time as would a larger group.

examinations

The syndicates drew attention to the recommendations of Dr. D.E. Billings.

In a modular programme units may be individually assessed but an overall integrated evaluation is also vital and professional bodies must be involved in this. There may be a case for differential assessment of given units for different applications.

Colleges could validate only the academic and vocational content of a course. The clinical content would then depend upon probation service and

this is disliked by students. If academic, vocational and clinical content are examined and assessed the college may have to run a validating service to designate the students, performance for the professional and registration boards even if it cannot teach clinical subjects because it has no clinical expertise staff. There may be a case for CNAA to validate both degree and degree level non-degree courses together.

employment

Part time students are in post. For full time students the college has a responsibility to help students find employment and to ensure that its part time course will give prospects of employment. The close involvement of biology lecturers with biological industry has ensured this in the past, but what happens if demand for full time graduates drops and competition for FT students increases?

professional bodies

Professional bodies can lose influence and even income when other agencies take over the administration of examination and qualification procedures. It may be in their interest for them to come together to validate rather than hand over validation to appointed assessors and to ensure ethical standards are maintained.

Five areas for potential development were identified and introduced by visiting speakers and conference members. Participants then divided into syndicates according to their preference of interest. In view of the enthusiasm of all participants to discuss one topic, the possible ways biology departments might respond if required to assume greater responsibilities for paramedical training, this became a third project and all members had the opportunity to discuss it.

K W Thomas, Dean of School of Natural Sciences. The Hatfield Polytechnic.

"To consider the factors affecting the teaching of biology to secure effective education and the best use of limited resources."

national and regional factors

Mr. Thomas listed some of the national and regional factors which affect biological education: the number of students available; the number of centres offering different specialisms in the subject; the nature and level of courses offered; the density of biological industry in the area, its employment and training policy and the number of suitable sandwich placements it offers; 'feeder college' facilities and co-operation; local travel facilities; ease of transfer of students between colleges; residential student accommodation; and the norms used for calculating staff establishments. Policies on course distribution were determined by government departments, Regional Advisory Councils, LEAs and industries.

Mr. Thomas drew attention to a number of questions pertaining to these national and regional factors which might be discussed by syndicates: Are biologists effectively represented where it matters, and are there enough of them, considering the diverse nature of the subject and the number of courses and students involved? Are biologists mistaken in thinking that physical scientists cannot adequately represent them? Is the level of competence in the subject appropriate at the level at which important decisions are taken? Are there too many people with self-interest taking decisions at RAC, CNAA and Institute level? Are there too many validating bodies acting independently of each other? Is there a virtue in external validation? Should expansion in the public sector and in the universities continue to be separate? Are the student/staff, accommodation 'norms' employed appropriate? Is biology already over-provided for in FE? In

determining course distribution should there be a 'laissez-faire' policy or control? If control, what type should this be? Should there be a few national centres offering a full spectrum of courses, a larger number of centres offering distinct parts of the range of courses, or centres which teach at one particular level?

inter-college co-operation

A number of issues were raised concerning inter-college liaison. Should students be encouraged to transfer when more appropriate provision is made elsewhere? Should courses have similar structures to facilitate transfer? Should staff specialists circulate between colleges giving short courses at different centres? Should field centres be jointly developed and financed? Should there be a central pool of laboratory schedules, lecture hand-outs and examination questions? Should there be central control of admissions, sandwich placement, first employment etc? Are sufficient FE staff to be appointed as external examiners? Should extra-college facilities, e.g. hospital laboratories, be more widely used?

effective use of resources

Since no course could cover the whole of the biological sciences there were a number of strategies which would improve the use of resources. Could essential or central themes be identified which were common to all biologists, or to wide areas of the spectrum of life science courses? Should all students in a group share a common background of vocabulary and training and experience. Are there fundamental non-biological courses that all biologists should take? Who should teach them and how can they be integrated into the biological courses? Are the traditional number of contact hours for students and staff justifiable? Are traditional teaching methods effective? Is the balance of theory to practical sound? Is individual practical and project work important? Can good course design encourage a more sensible use of resources? How does modularisation affect standards? Will mergers with colleges of education which have very different traditions affect standards? Can biology be taught at higher levels without a vigorous research effort? How sophisticated need equipment be? Should students in different years of the same course and in different courses be grouped together for some classes? Does an obsession for assessment reduce effectiveness? How far does an effective education depend upon non-academic factors such as staff student relationships? Are efficiency and effectiveness compatible?

internal factors

Factors which might affect the best use of resources were identified as the total area and flexibility of accommodation especially laboratories; the capital equipment and replacement of equipment policy; revenue provision; the staff development policy; the amount of technical, library and administrative support; the academic structure of the college; contact hours; research policy; sabbatical leave; availability of part time staff, etc.

Factors affecting courses specifically were the number of examining bodies involved; the curriculum hours requirement; the different modes of study for the same qualification; timetable constraints; the number of students on the courses and how this fluctuates from year to year; the design of the courses (whether they have one or several prescribed pathways; free choice

modules, width of the biological spectrum covered,etc); project demands; and demands from other disciplines for courses in biology.

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There was concern that whilst biology had not directly followed the physical sciences in allowing courses at too many centres, there were 'back-door' entry methods by the inclusion of biological modules in combined science, environmental studies or modular schemes which could be used as a mechanism for later establishing specialist degree courses. A second problem was that the validation of biology in the different degree structures was carried out by different panels of CNAA and there appeared to be a variation in the standards required. This called for urgent exchange of information between biologists in the different panels and between validating bodies to ensure parity.

Some discussion took place on the rationalisation of curriculum structure and syllabus content to effect savings in resources. On the question of a common core, it was felt that this was more a matter of approach and attitude of mind to problems rather than a clearly defined body of knowledge. Three features were held to be characteristic of biologists: a flexibility of approach and willingness to change; a capacity to cope with variables; and a recognition that perfect solutions were rarely possible. These characteristics could be achieved by courses using very different information.

Modularisation was seen to be one method of rationalisation but it was too often regarded as an end in itself. The success of a course would in the end be determined by the acceptability of its students by society and as yet it was too early to measure the effectiveness of modular courses. The syndicate felt that these were being developed with indecent haste, as a panacea solution. The assumption that modules should all be the same size was criticised and it was thought that the requirement for linear progression of modules could be over-emphasised. The effect of new course structures was seen as potentially damaging to important staff student relations and to the students' sense of identity with the course.

Turning to the question of projects, the syndicate defined these as exercises requiring some degree of originality on the part of the student, which could range from a highly supervised extended practical exerise to open-ended research. It was agreed that the project demanded more resources than other forms of biology teaching, in terms of staff and student commitment and time as well as materials and equipment. There was agreement that projects were of benefit to students and should form an essential part of their study. However, projects made heavy demands upon students, demands which were often self-generated. It would be worth while to question whether the effort expended on project work was directly proportional to the benefits derived

by the student and to be aware that other aspects of the student's work could suffer as a result of excessive involvement with a project.

The act of doing the project and the thought processes involved were felt to be more important than the precise nature of the project and the sophistication of the methods and equipment used. Therefore it was likely that economies could be made without loss of the unique advantages of project work. The group thought that there were advantages in confining project activities to areas in which staff were doing research so that they would be competent to supervise and the necessary equipment would be available. Finally, it was noted that educational objectives and assessment were two important aspects which were not necessarily compatible. The balance of importance attached to each could have considerable implications for the nature of the project, its location (at work or at college), supervision and assessment.

L G North, Head of Department of Biological Sciences, Ewell County Technical College, Surrey.

"To consider the ways in which the education service might respond to the needs, in a variety of specialisations, of small groups of students in areas remote from large biology departments and where full time release is impracticable."

"Possible ideas for discussion are:

(1) Co-operation between colleges(and LEAs if necessary) in avoiding duplication of staff specialities and specialist equipment, and following this:

(a) block release for students to attend different colleges throughout the year, or

(b) moving the staff and equipment while the students remain stationary.

(2) The common content of various courses could be identified and the small number of local students could be integrated into classes for this part of their course. They could then be sent to other colleges only for their specialised areas of study.

This concept of colleges specialising in certain topics and being attended by students from a wider than usual catchment area ties in with TEC proposals.

(3) The use of Open University or radio teaching methods involving:

(a) local tutors;
(b) touring specialist tutors;
(c) co-operation with industry, research establishments, hospitals and colleges for practical facilities;
(d) local radio and television;
(e) summer schools;
(f) preparing tapes, films and video-tapes;
(g) programmed learning;
(h) use of correspondence school methods.

Certainly there are problems in small numbers of students requiring particular specialisms in their HNC which would not be viable numbers for a college to offer as a course and would cause wastage of resources. Yet many part time students work in areas far from large colleges where they might be able to take their specialist course of study. It is often not possible to give them block release for many work in small research laboratories where there are only two or three technicians, so alternatives to attendance at colleges must be found."

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The syndicate limited its discussion to HNC Applied Biology and MLS. The problem was defined as being students geographically isolated or organisationally isolated, where, for instance, they are the only specialists in a firm.

The group felt that block release for such students was the ideal solution and that moving staff and equipment about was uneconomic and would damage equipment. On the possibility of sending students to distant colleges for only the specialist content of their course, it was thought that this would still create travel problems for the geographically isolated and there would be problems in timetable co-ordination. The use of Open University techniques was deemed to be the only system possible. In connection with this peripatetic tutors would be required. They should have plenty of experience of HNC and also industrial work. Appointed on a regional basis, e.g. the RAC regions, they could work as a group to run a national scheme.

With regard to the problem of practicals, it was agreed that some could be done at work, and even at home. However, quantitative biology in particular would have to be introduced at a summer school which would effectively start the course and then further practicals for each of the specialisations would be carried out at two further summer schools. It was suggested that each college could be responsible for a summer school and the teaching material for a specialism. It followed that the Joint Committee

would have to accept low practical hours and very little attendance even though the course could extend over three years. Employers would be expected to provide study time.

It was accepted that the system suggested would have certain inherent problems. Employers might tend to take advantage of the scheme and avoid releasing staff. Students might not be motivated to undertake such a difficult mode of study. The cost to the community would probably be greater than for other forms of study, although this would be partly recoverable if the course were made expensive.

S F Everiss, Vice-Principal, Paddington College.

"To examine the possibilities for providing retraining in the biological sciences for teachers in physical sciences and mathematics undertaking increasing duties in biological science departments and sections".

Some of the problems and questions which might be discussed by syndicates are:

(1) The difficulties maths and physical science teachers may have in teaching biology students.

(2) Inter-subject/inter-departmental problems.

(3) To what extent can the above difficulties be solved without retraining?

(4) Is it possible to identify any retraining needs?

(5) Can staff in post accept retraining needs?

(6) Are new staff needed, e.g. biophysics and biomechanics teachers?

(7) Who can offer retraining or new subjects?

(8) Is there a need for special courses? How long should they be?

(9) Should staff be given sabbatical leave?

(10) Is there a case for biologists tackling everything in the course or is it preferable to liaise with colleagues in other departments?

(11) Do non-biologists need 'biological-thinking' courses or basic biology courses for biological student teaching?

(12) Are there differing approaches to science and if so is this a problem or an advantage?

(13) Can the present situation be altered by modular course structure?

(14) Is there any advantage in team teaching.

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Problems associated with the teaching of mathematics, physical sciences and general studies to biology students were discussed. For institutions with the 'service' concept, the following points were identified:

(a) Communication - there was a need to carefully explain the purpose of of the teaching. This could be done at formal and informal levels, the latter being particularly effective. The presence of the service staff on course boards of study and curriculum development committees was an important factor for integration of this teaching with the rest of the curriculum.

(b) Careers Structure - there was a need to ensure that service teachers had adequate careers structures.

(c) Criteria for Service Teachers - they must want to be involved; course tutors must want them to be involved, and the material they use must be dealt with in an agreed manner.

The syndicate then reported on retraining. This was necessary as courses changed and old specialisms became redundant. Retraining was not merely an increase in academic knowledge but necessitated a change in conceptual approach. The experience of people who had already made such a change should be sought. Various means of retraining were discussed, including attendance at parts of courses already offered in the institutions and specially designed 'in-service' courses to which teachers could be seconded. It was thought important for seconded teachers to establish contact with the frame-works in which they would later work by being given appropriate teaching duties as soon as possible.

Dr. F C Webber, Head of Department of Biological Sciences, The Polytechnic, Wolverhampton.

"To survey the requirements and provision for 'field training' (e.g. sandwich placement) and to make recommendations for effective identificatification and allocation of opportunities"

"Little attention has been paid so far in this conference to the sandwich course, but the advocates of this type of course would justify its inclusion in the spectrum of biology courses offered in the college in a number of ways. They believe the course provides experience in doing a job instead of merely learning about it; allows students to sample a limited range of industrial biological situations which may in itself assist them in deciding on their eventual careers; provides a maturing experience which leads to increased motivation later in the courses, etc. If we accept these arguments and set up sandwich courses, as many colleges have done, what do we, as educators, actually require of the sandwich interlude? In an ideal situation, the number of sandwich placements would be in excess of the number of students needing places, so that we could be selective and attempt to match the academic attainment of a sandwich student with the work that is available. Students enter Industrial Training at different periods during their course of study - ranging from placement after only six months post 'A' level study, to placement after two years of college study and we should pay more attention to matching their level of attainment to the jobs which are available, although, of course, there are simply not enough places to enable us to do this properly at present.

If we are going to try to match the training facilities to the students attainment, we need a fairly detailed job specification from the co-operating employer. It is important to know that the employing institution takes care in devising training programmes, and includes some induction period appropriate to the kind of work which is carried out in the laboratory, firm or industry as a whole. It is desirable that there should be a progressive schedule of training in the range of techniques and procedures which are the work of the employing institution, culminating in the opportunity to carry an item of individual project work. Unfortunately, when colleges request this of firms they often become rather wary and there is a danger of losing some of the placements. Therefore there is a need for tact in extracting information about training from employers.

On the subject of supervision, it is important that college staff should visit firms, see the students and their immediate supervisors and ensure that arrangements are adequate. The college should monitor students' progress during their training.

The provision of sufficient sandwich placements is a delicate issue because the situation fluctuates from year to year according to the economic climate and the state of the industry. An attempt must be made to keep fluctuations in provision to the minimum.

The most important question of all is how to ensure that professional standards are instilled in the student while on training periods and then maintained when he returns to college.

Finally, perhaps I might suggest that as UCCA has worked so well and there is now talk of a similar scheme for polytechnics, there might be value in such a system applying to sandwich courses."

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First, the group considered some existing arrangements for practical training placements:

(a) HND (MLS) three year SW course, Bristol Polytechnic and Llandaff College of Technology.

This award leads to registration to practise and includes a training period in approved laboratories under supervision (82 weeks at Bristol, 72 at Llandaff). Professional training is divided into initial, general training in several departments followed later by specialist training in the selected option and includes a project. The Area Health Authority jointly with the college nominates suitable training establishments. The AHA provides funds for a stated maximum number of students who are selected for the course by a joint panel of AHA, college and hospital staff.

(b) B.Sc. and M.I.Biol. and HND (AB), Manchester Polytechnic.

Placement depends upon personal contacts. The choice of placement depends upon student preference and posts available. Employers select students after interview and pays the students' salaries. The training programme depends upon the nature of the job. The diversity of applied biology leads to difficulties in identifying a plan of basic training.

(c) CGLI Dental Technologists, South London College.

The students fall into two groups: 60% are hospital based, employed by the NHS, and 40% are college based, placed in small private dental laboratories on an ad hoc basis.

(d) HND (AB), Bristol Polytechnic and Seale Hayne Agricultural College

Students are placed in the agricultural college.

(e) HND (Biology), Scotland.

Many students are placed in university laboratories.

The syndicate felt that the high level of organisation of the MLS programme in a narrow and structured industry simplified the problem of student placement. It should be possible for the college to identify more specifically the areas of work which are common to all applied biology students, e.g. instrumentation techniques, which would assist employers in the planning of training programmes. Employers need to know the students' capabilities and what is expected of themselves and the students.

The requirements of the training were identified:

(a) the provision of vocational experience giving an understanding of responsible work in an adult group situation;

(b) work experience must be relevant, reasonable and systematic;

(c) there must be an identification of skills needed and training in those skills; and

(d) performance in the training period can be taken into account in the final award by the development of a student profile by an employer and the college.

In view of the fact that as many as 450 students required placement each year, the syndicate suggested that a national clearing house might rationalise distribution. Operational disadvantages were cost and the diversity of biological employment. As training placement was not a 'key activity' of Industrial Training Boards, it was unlikely that there would be any reimbursement of payment for training placements. The syndicate thought that perhaps this ought to be reviewed as ITB payments would be preferable to giving students mandatory grants for the training period. It was estimated that 50% of training places were offered by Government-financed establishments.

PROJECT C

"To consider the ways in which biology departments could respond if the education service were required to assume wider responsibilities for paramedical training."

Introduction

E Norris, HMI, Department of Education and Science.

In presenting this project introduction, Mr. Norris circulated a number of documents to members, extracts from which appear below.

1. Terms of Reference

(This is based on a statement prepared by DES and DHSS for a Council of Europe Working Party. It contains a number of important statements of fact and principle agreed by both Departments.)

1.1. The term 'para medical' is taken to mean the professional and technical careers, other than medicine and dentistry, directly related to the operation of the health services. These include:-

(a) The scientific and technical services connected with diagnosis, treatment and related services, (laboratory and clinical services).

(b) The remedial professions (occupational therapy), physiotherapy, remedial gymnasts, speech therapy, orthoptics.

(c) The nursing and midwifery professions.

1.2. Both DES and DHSS have central policy interests in ensuring the provision of suitable training opportunities in their fields but direct responsibility for the operation of courses is devolved to universities, LEAs, medical schools, and regional and area health authorities.

1.3. Forms and Levels of Training

There is no standardised pattern of training for all the professions and occupations. The form and level of each has individual features of recruitment, and disposition between education and hospital service based training which has evolved over many years. Reviews of the state of recruitment

and training are carried out by the two Departments in conjunction with the institutions providing courses, and the professional bodies/institutes/societies representing the many occupations in this field. These bodies also frequently act either partially or solely, as examining bodies for the qualifications awarded for their particular course of study.

1.4 Curriculum and Qualifications

The health services make use of 4 main groups of qualifications in the assessment of the academic attainments required for appointment. These are:

(a) University degrees or degrees awarded by polytechnics in a variety of scientific and allied subjects.

(b) University degrees in subjects directly related to the para medical profession, e.g. pharmacy, speech therapy, dietetics.

(c) Nationally recognised technical awards, e.g. national certificates and city and guilds.

(d) Qualifications awarded by the professional societies and institutes.

In addition to possessing one or more of these the student will have taken a course of 'professional training' or will have served a period of probation in the health service during or after his academic course. In general both academic attainment and progress made in professional training is taken into account for appointment and promotion purposes. Appointment to a qualified grade is rarely based on academic qualifications alone, the determination of competence to practise being the responsibility of the qualified health service staff who supervise professional training.

For the professions of medical laboratory technology, chiropody, dietetics, orthoptics, radiography, occupational therapy, physiotherapy, and remedial gymnastics, known collectively as the 'Professions Supplementary to Medicine' and for pharmacy a formal process of 'State Registration' is required by law.

Nurses, midwives and speech therapists are also "registered" but by separate procedures.

1.5 Future Developments

General trends suggest that the education and health services will work more closely together in the provision of courses. There is a trend towards bringing the profusion of individual qualifications into a number of inter-related groupings whereby greater academic and operational interchange can be obtained. Continuing attention will be given to improving the relationships between education based courses and the profession training in the health service."

* * *

2. "Some Legal Statutory and Operational Features

2.1. The primary purpose of the effort made by DHSS in training is to provide the staff required to operate the health services. Competence to practise and service to the patient is an over-riding priority and although educational considerations will be made wherever possible they remain a secondary objective. Competence to practise contains three basic elements: personal qualities, academic attainment and job skills. The formal procedures for the two latter are broadly defined as academic and professional training respectively. These characteristics impose certain features in the extent to which H/FE may respond to NHS needs. Many qualities related to professional training are only developed in the hospital and its allied departments and many are not examinable in academic terms, i.e. they are not easily identified, accepted or measured as educational. Unless therefore the two departments decide that H/FE should take over the operation of the hospital service for education and training purposes there is some limit to the contributions H/FE may make and it can only reasonably expect to be involved in part of the qualification process.

2.2. Registration is a formal statutory process and in the health services is required for medicine, dentistry, pharmacy, the professions supplementary to medicine and nursing. Each have separate councils which are established by Act of Parliament but are independent of government and of each other. They are required by law to:-

(a) Keep a register of properly trained and qualified practitioners.

(b) Describe the responsibilities of those in their charge and ensure that the qualification process is adequate (e.g. medicine 'only those who are registered may prescribe dangerous drugs, sign death certificates, be employed in a clinical capacity in the health service, act as medical officers of health or give an anaesthetic').

(c) Consider and approve courses of training, qualifications and institutions providing training. Each council has authority to appoint visitors to inspect institutions.

(d) Provide appropriate examinations for their professions if they decide this is necessary. (The General Medical Council particularly issues recommendations about every 8-10 years concerning the undergraduate medical curriculum and every medical school must conform to these if it is not to run the risk of having approval withdrawn. In this sense any of the councils may, if they wish, influence the curriculum.)"

* * *

3. Statistics

Table 1

Student numbers and FTE in FE and non-FE by groups of professions

Groups	FE					Non-FE		Grand Totals	
	FT/SW	PTD/BR		Totals		FT/SW	FTE	Nos.	FTE
		No.	FTE	No.	FTE				
STS	120	6850	1520	6970	1640	-	-	6970	1640
CS	950	1623	360	2573	1310	4100	4100	6623	5410
RP	880	-	-	880	880	3530	3530	4410	4410
TOTALS	1950	8473	1880	10423	3830	7630*	7630*	18000*	11460*

STS = Scientific + Technical Services

CS = Clinical Services

RP = Remedial Professions

* of these figures, 5400 (in each case) represents provision for CS and RP in NHS schools.

Table 2

Student numbers and FTE in FE and NHS schools, by groups of professions

Group	Student numbers		FTE		
	Total	% in FE	Total	% in FE	% in NHS schools
STS	6970	100	1640	100	0
CS	6623	17	5410	24	47
RP	4410	20	4410	20	70
Nursing	8500	less than 3%	30000	less than 1%	100%
TOTALS (excluding Nursing)	18000*	58	11460*	33	47

Table 3

Student numbers in FE and NHS schools by type of attendance

Attendance	FE	Non-FE	Totals	% in FE
FT/SW	1950	7630	9580	20
PTD/BR	8473	-	8473	100
TOTALS	10423	7630	18053	58

Table 4

FTE in FE and NHS schools by type of attendance

Attendance	FE	Non-FE	Totals	% in FE	% in NHS Schools
FT/SW	1950	7630	9580	20	56
PTD/BR	1880	-	1880	100	-
TOTALS	3830	7630	11460	33	47

"General Features of the Statistics

This information is derived from a variety of sources from 1972 onwards and it varies in accuracy and reliability. Those for FE courses are probably fairly accurate.

It includes some very generalised information on Nursing as this gives some useful hints of the size of the population in relation to total NHS demands.

An analysis of the present situation and some assessment of the effects of future trends, is as follows:-

a. The health services have about 100, 000 students, and something in the range of 350, 000 - 400, 000 staff employed in the para medical groups. Nearly 300, 000 of these are nurses. We would estimate the size of the non nursing groups in employment to be about 45, 000 (12, 000 STS, 18, 000 CS, 16, 000 RP).

b. This group is provided by (and might include) some 18, 000 students, about 11, 500 FTE. Overall about 33% of these are provided in H/FE.

c. The tables describe basic features of the provision being made, and its distribution.

Of about 11, 500 FTE students,

about 2000 FT/SW courses in H/FE

about 1800 - 2000 PTD/E courses in H/FE

about 5400 FT/SW courses in DHSS and allied schools

about 2200 FT/SW Universities and others

DHSS provision (orthoptists, radiographers, chiropodists, occupational therapists, physiotherapists, remedial gymnasts) accounts for more than 50% of the FT/SW load.

Between the four main groups HFE and DHSS provision is respectively:-

Scientific and technical services H/FE almost 100%

Clinical services H/FE 39% DHSS 47%

Remedial professions H/FE 22% DHSS 70%

Nursing and midwifery H/FE less than 10% DHSS 90%

University contribution is about 20 - 25% overall: 15% Clinical services, mostly pharmacy and dietetics, 8% remedial, mostly speech therapy. The bulk of H/FE FT/SW provision is in pharmacy, dietetics, chiropody and speech therapy."

* * *

4. "The Increased Use of HFE Facilities by NHS

DES in conjunction with the LEA's, UGC and the RAC's has a duty to consider the provision to be made to meet national and regional needs. In general it is necessary for DES, and its associates, to know more than it does at present about the future calls likely to be made on the H/FE system for what might be broadly termed the "NHS field".

The following issues are being discussed between the DES and DHSS.

(1) Policy

What are DHSS views of the desirability of proposals involving the transfer of parts or the whole of NHS training from hospital schools and private teaching foundations to H/FE? Various reports and recommendations on the future training pattern for the professions are being taken into account most of which suggest that closer involvement with the education service is desirable, and that awards of a more nationally recognised character (e.g. Degrees, HNC/D, etc.) should be provided. It is also known that in many of these groups a desire for the expansion and improvement of training is coupled with some disenchantment with salary and career prospects. It is difficult for DES and other outside NHS to identify how much the pressure for better training or nationally recognised qualifications is educational rather than socio-economic. Some attempt is therefore being made to establish an agreed view on four questions:

(a) Is there evidence that service to the patient is failing in any of these professions because training standards are inadequate and that therefore greater training resources should be committed?

(b) If so, can this be best brought about by DHSS within its existing training system (including the necessary changes in career and salary prospects) or by some kind of joint function with H/FE?

(c) If the latter, should the aim be merely to provide a "service" for the existing qualification courses or to link the training to the national system of educational qualifications during or "end on" to the courses?

(d) Is there evidence to show that the use of clinical training facilities would be more efficient if the "academic courses" were reorganised and H/FE based?

(2) Numbers and Locations

It follows that if these changes are to take place DES, et al, would need to know the numbers requiring training in H/FE and some idea of the areas in which the work might be concentrated. It is also necessary to know how H/FE courses might be located in relation to NHS based clinical training and particularly how this might be affected by any reorganisation DHSS might carry out in the number and location of their "schools".

(3) Registration Boards and Professional Societies

DES will also need to be assured that any move towards H/FE has the support of these bodies and that the problems of validation have or will be considered when the arrangements involve a split of existing training between its H/FE based academic parts and NHS based clinical parts. Since the clinical component is essential to the qualifying process we must be sure that the structural and awarding changes imposed by moving parts of courses out of the hospital service are fully agreed as being benefical to the total training.

(4) Costs

This is the most difficult practical issue. Proposals to transfer work from NHS to H/FE represent a long term and potentially very large transfer of work and therefore costs from NHS funded (by Treasury) to DES funded (UGC) and/or DES/LEA funded expenditure (Treasury and local funding). Without a compensatory transfer of NHS funds to the education service the total cost to the taxpayer would increase."

* * *

5. "Curriculum and Organisational Features

Courses for para medical professions leading to awards qualifying for practice comprise

(a) Academic studies: conventional subjects.

(b) Vocational studies: generally multi-disciplinary, a synthesis of academic and other forms of organised knowledge applied to operational objectives.

(c) Clinical/professional studies: development of knowledge and skill in practice to standards fit for use.

The balance between a + b + c and the degree to which each is measured (in the examining sense) varies between the groups. For many a + b comprise the whole of the measured award, c being derived from probationary experience (e.g. scientific and technical services). a + b + c in a totally integrated form is characteristic of the groups having direct responsibility for patients and particularly the inclusion of "c" in an examined form (e.g. nursing, physiotherapy etc.). Although these components may be separated into an H/FE based "a + b" and a separately validated NHS based "c" there is some evidence to suggest that while these professions might gain a degree, HNC/D, TEC H C/D, or Dip HE they might have a great deal to lose as well. H/FE awards could respond in their present form to a + b but only with difficulty to c. New awards combining national recognition with the validation of a, b, c as an integrated and "qualifying" whole would need to be devised if H/FE is to take over, with the same facility, the qualifications at present provided by the Societies.

a + b are within the capacity of H/FE. c is not because:

(a) H/FE does not run hospitals.

(b) H/FE does not have the staff sufficiently in contact with medical practice to comprise a body of opinion on competence nor would it be desirable for H/FE to become so involved.

The key to an academic strategy whereby H/FE might respond to paramedical developments is

(a) the integrated presentation of a + b + c by the joint use of H/FE and NHS resources

(b) the formation of awards which adequately represents a + b + c in a form which achieves

- recognition by the educational network for national awards and further access purposes
- the definition of student performance in fitness to practise terms.

At present there is no satisfactorily worked out mechanism for the integrated validation of courses in this way available to H/FE and NHS.

Clinical/Professional Studies: "C"

The provision of c is operationally the key to the whole exercise. Clinical training is highly specialised, hospital dependent, and highly labour intensive. The ground rules for this side of the operation are

(a) The clinical training capacity of NHS must remain in operation and be both improved and expanded.

(b) Staff available for clinical training are in short supply. More need to be trained and their transfer from NHS to H/FE not only reduces the number available but might remove them from direct contact with hospital work.

(c) The clinical training capacity would need to be grouped in association with selected centres so that the cost advantages of concentrating a + b off-set the high cost of c. Even more advantages come from the grouping of a + b with other similar or identical courses.

Alternatives

Present methods are based on two considerations

(a) that a + b continuously associated with c has some inherent virtues.

(b) that students will be capable (and in many instances are expected to be capable) of taking over certain hospital duties comparatively early in their course of training.

Without altering the length of training the programme could be changed to a college based a + b (Degree, HNC/D, HTD/C, Dip HE) followed by an NHS based c. This is a much simpler method and is already employed (medicine, dentistry, pharmacy, etc.). It is more adaptable to the formation of educational awards at an initial stage in the qualification process. There would be a number of disadvantages:

- the alternation of a + b with c might be vocationally significant
- making the first stage a + b vocationally relevant might be beyond the practical experience of colleges. Less relevant, more academic courses, might be less encouraging
- clinical training would need to be drastically reorganised
- regulation of recruiment problems."

* * *

6. "Questions for Consideration

(i) What advantages and disadvantages to the student, the hospital service, and to society might come about if the training for para medical staff, at present based in NHS, were to be partly or wholly transferred to H/FE?

(ii) What arrangements for curriculum and awards will be necessary if new forms of provision are to advance the educational provision yet retain the facility for qualifying fitness to practise?

(iii) What demands are these transfers likely to make on H/FE and how might they be accommodated in relation to the requirements, existing and projected, from other sectors?

(iv) What regional and local arrangements are likely to be required to ensure that the components of the courses may be provided with the maximum of facility and convenience.

(v) What curriculum research and development will be required to provide the academic and vocational elements of this work?

(vi) Examine the scope and limitations of the college based followed by clinical training alternative."

* * *

Introducing these papers Mr. Norris said that there were a number of operational factors involved. Bearing in mind that there was no distinction between education and training in this field, the transfer of paramedical training was a policy issue. Secondly, the transfer of training either wholly or in part to FE could only be considered if it was felt that such alteration would provide better education. Thirdly, there was the question of whether, if a transfer took place, students should continue to take the same qualifications or take new ones, and what the consequences of that might be.

Referring to Paper 2, Mr Norris stressed that competence to practise was the overriding aim of training. Education was obviously connected with this but was a secondary consideration. Indeed, there were many desirable qualities, especially those connected with handling patients, which were not particularly educational in the sense that they are developed in the process of education. People were either born with these qualities or derived them from their social background. Moreover, they were not measurable in the educational sense.

Commenting on the statistics, Mr. Norris said that if the non-nursing groups were to move into H/FE on some kind of 50/50 system, the lowest number of FTE students would be about 20,000. This was the number of students who would fill three to five polytechnics. While this would not happen suddenly, the signs indicated that it might happen over the next ten years or so. It was likely that the remedial professions and radiography would move first, and that the nurses would take a comparatively long time, for there were some problems in the management of nursing and also complicated emotional and political difficulties. However, over the next three or so years it was quite likely that the transfer of about 12-14,000 students would take place. In view of the amount of money involved, this was a major policy issue.

Paper 4 is a modified version of a civil service 'Issues Document' designed to size up the advantages and disadvantages of increasing the use of HFE facilities by paramedical students which Mr. Norris produced early in 1974. He commented that Paragraph 4.1 is probably the key to the whole exercise. "We have asked the DHSS whether they think the transfer of students to H/FE from hospital schools is desirable. It must be remembered in relation to any tendency to move towards degree courses that these may not be the most suitable types of training for people intending to work in the paramedical field. Nor should it be assumed that degrees and other educational qualifications are automatically effective means for bringing about reform in salary and career prospects. You cannot solve complicated employment problems simply by giving everyone a degree; the problem is in the personnel management."

Syndicate Reports

There was unanimous support for a system of paramedical education which would use both NHS and H/FE resources. It was felt that students who received training in the hospital service only were at a disadvantage. Often students were regarded as an extra pair of hands and routine lectures could be postponed if there was urgent clinical work to be done. The use of the facilities of the education service would give an opportunity to improve the academic content of the training and therefore establish better status for the paramedical professions. This in turn would probably attract better recruits and improve pay.

Conference members were equally convinced that paramedical training should not be entirely carried out in the education service. Firstly, clinical conditions could not be simulated in colleges without a great deal of expense. Secondly, there were not enough specialist staff to teach all the different areas in which biology students might make their careers. It was agreed therefore, that the best solution would be to have a joint scheme operated by the NHS and the HE/FE service.

It was apparent from the syndicate reports that members did not wish to see a repeat of the post-1967 HNC/MLS free-for-all. The essence of the exercise was to ensure that the clinical components were synthesised with the academic units. It was thought that some controlling mechanism would be needed, perhaps on a regional basis. It was noted that it was unfortunate that the RACs did not correspond with the new hospital regions, as this would have been an obvious solution.

On the organisational features of the courses themselves, it was generally felt that the in-service work and the college work should run concurrently, rather than the practical period being at the end of the academic training. Therefore members did not think the two year Dip HE course followed by a practical course was advisable. Some thought that at the beginning of the course the emphasis should be on practical work, so that students could decide whether they were pursuing the right careers. Possibly they could do two days a week at college and three days a week in the clinical situation, or a short block of academic work at college and then a period of professional study.

The type of award paramedical students should work for was a subject of lengthy discussion. One member suggested that the Certificate to Practise should be kept separate from the academic award. There were a wide range of intellectual abilities among people who were perfectly competent to practise as operators. These people should not be debarred simply because they do not possess high intellectual potential. Those who did have the academic potential to progress to clinical teaching, administrative posts and so on would be able to prove this by their success on the academic part of their training.

On the introduction of HNDs, TEC and other similar qualifications for paramedical students, members felt that this should not be done too hastily. While existing professional qualifications needed some rationalisation, they were well known and therefore had professional respectability, and those students who did well in them could in any case proceed to further academic awards such as degrees. It was possible that in time the qualifications of professional bodies would naturally evolve into awards such as HNDs but this process should not be rushed.

Syndicates also stressed the need for short in-service training courses to fit practising paramedical biologists for new fields of work as their own became redundant.

Members

R A Bawcutt	Principal Lecturer, Biological Sciences, Sheffield Polytechnic.
Mrs P Baxell	Principal Lecturer, Microbiology, Ewell County Technical College, Surrey.
J R Bradshaw	Senior Lecturer, Biochemistry, Brighton Technical College, East Sussex.
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R S H Finney	Principal Lecturer, Biology, Brighton Polytechnic.
Dr J Ford	Senior Teacher, Biology, Napier College of Commerce & Technology, Edinburgh.
G W Griffin	Principal Lecturer, Medical Laboratory Subjects, Bristol Polytechnic.
Dr L A F Heath	Head of School of Environmental Sciences, Plymouth Polytechnic.
Dr R M Jarman	Head of Faculty of Engineering & Science, Harrow College of Technology and Art, London.
R T Jones	Senior Lecturer, School of Pharmacy, Portsmouth Polytechnic.
Dr D A Kennedy	Head of Department of Molecular & Life Sciences, Dundee College of Technology.
G Leadbeater	Head of Department of Life Sciences, Trent Polytechnic.
Dr J Leggett-Bailey	Principal Lecturer, Biology, Cambridgeshire College of Arts and Technology.
Dr R A W Longden	Head of Department of Chemistry, Computing and Applied Sciences, Warley College of Technology, Sandwell.
Dr J T MacConnell	Head of Department of Biological Sciences, Glasgow College of Technology.
J Mellerio	Principal Lecturer, Physiology, Polytechnic of Central London.
D R A Mobbs	Chairman Modular Course Committee, Oxford Polytechnic.
M D Morisetti	Head of School of Biological Sciences, Thames Polytechnic.
L G North	Head of Department of Biological Sciences, Ewell County Technical College, Surrey.
A Peat	Principal Lecturer, Biology, Sunderland Polytechnic.
G G Shone	Principal Lecturer, Biological Chemistry, Kingston Polytechnic.
M Thomas	Senior Lecturer, Applied Biology, Ewell County Technical College, Surrey.
K W Thomas	Dean of School of Natural Sciences, The Hatfield Polytechnic.
Dr J M Thompson	Head of School of Biology, Leicester Polytechnic.
J O Wagstaffe	Principal Lecturer, Laboratory Sciences, South London College, ILEA.
Dr F C Webber	Head of Department of Biological Sciences, The Polytechnic, Wolverhampton.
Mrs P H White	Principal Lecturer, Science, Paddington College, ILEA.
Dr J R P Williams	Chairman of Faculty of Science, The Northern Ireland Polytechnic, Newtownabbey.
Dr R E Yorke	Principal Lecturer, Biochemistry, Oxford Polytechnic.

Visiting Speakers

A J Branton	Architect, Laboratories Investigation Unit, Department of Education and Science.
F Drake	Furniture Designer, Laboratories Investigation Unit, Department of Education and Science.
S F Everiss	Vice-Principal, Paddington College.
B Gregson-Allcott	Education Officer, Institute of Biology.
Dr D W Hill	Research Department of Anaesthetics, The Royal College of Sergeons of England.
E Norris	HMI, Department of Education and Science.
Dr K Wilson	Principal Lecturer, Biochemistry, The Hatfield Polytechnic.
W M Young	Lecturer, Bio-Medical Subjects, School of Further Education, Jordanhill College.

Conference Tutors

Dr T Green	Head of Department of Science, Bristol Polytechnic.
A Albrecht	Staff Tutor, Coombe Lodge.
C T Ferguson	Staff Tutor, Coombe Lodge.
J Latcham	Staff Tutor, Coombe Lodge.

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